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ABSTRACT

A Statistical Experiment Simulator (STEXSIM) has been developed which permits one to stimulate on a digital computer a wide range of experimental environments. As a teaching aid in applied statistics, it provides a means for an instructor to define a completely crossed factorial model with up to seven fixed or random main effects, three two-factor interactions, and one three-factor interaction. A student designs an experiment which probes this model in order to draw appropriate inferences. STEXSIM reads the design and "conducts" the experiment he has specified providing the resultant "observations" which the student then analyzes. This report discusses in detail the program including input specifications and output interpretation. Sufficient detail is presented to permit one to use the model himself. (STEXSIM is programed in FORTRAN IV.) The report also describes the formulation, execution, and analysis of 30 "student" experiments run using seven different "instructor" models. (Author/JY)

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THE DEVELOPMENT OF A STATISTICAL EXPERIMENT SIMULATOR

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January 1972

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HEALTH, EDUCATION AND WELFARE

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The services of the CDC 6400 computer so essential to the success of this project have been provided by the Computing Center at the State University of New York at Buffalo.

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I. SUMMARY

A Statistical Experiment Simulator (STEXSIM) has been developed which permits one to simulate on a digital computer a wide range of experimental environments. As a device to aid in the teaching of applied statistics, it provides a means for an instructor to define a completely crossed factorial model with up to seven fixed or random main effects, three two-factor interactions, and one three-factor interaction. A student designs an experiment which probes this model in order to draw appropriate inferences. STEXSIM reads the design and "conducts" the experiment he has specified providing the resultant "observations" which the student then analyzes.

STEXSIM performs as if it were an actual experimental setup but does so very rapidly and cheaply. Accordingly a student can experience for a number of problems the complete design-experiment-analysis process. This coupling of design and analysis is rarely achieved in a class in applied statistics. STEXSIM has the valuable added benefit of the instructor, having defined explicitly the experimental environment, being better able to interpret results to his students because he knows the "true" effects.

The STEXSIM model has been programmed in Fortran IV for the CDC 6400 digital computer. Being in Fortran it can be run on nearly any digital computer. This report discusses in detail the program including input specifications and output interpretation. Sufficient detail is presented to permit one to use the model himself. Furthermore the report describes the formulation, execution and analysis of 30 "student" experiments run using 7 different "instructor" models.

II. INTRODUCTION

A. OBJECTIVE

The teaching of applied statistics is generally characterized by the student being first presented with an introduction to theoretical considerations. To reinforce this understanding he is then given sets of problems to solve using the methodology being considered. Generally he is presented with sets of data which he is asked to analyze using the appropriate statistical procedure. All too often he is not even given the opportunity to select the procedure, the choice being dictated by the nature of the topic currently being covered. Furthermore he is not given the opportunity to design the experiment which would generate the data which he analyzes. At other times he is asked to design an experiment which, if executed, would permit the making of specified inferences. Unfortunately in this case he is usually denied the opportunity to run the experiment he has designed. The problem with this approach is the lack of coupling of the design phase with the analysis phase. The student is not faced with the complete task of first deciding how his data should be collected - what variables should be controlled, how many levels of each, how many observations, etc. - and then having to analyze his own data once it has been gathered. The reasons for this lack of integration are not hard to find for clearly the high cost and excessive time required to accomplish the process of setting up and running actual experiments are generally unacceptable for the usual class. It is recognized that students at times do gain this experience on one problem in the course of a major project or thesis endeavor. However, even in this case his experience is generally limited to a single problem.

The problem is clear: How can the experiment step in the design-experiment-analysis sequence be shorted at an acceptable cost? It has been the objective of this research to search for a solution to this problem. It is the task of this report to describe the success of the search.

The approach taken has been to explore and exploit the role of the digital computer. Through the use of computer simulation, experiments can be modeled in a computer language which then replaces an analogous real-world situation.

Consider first the general role of simulation. Simulation has been used for a variety of other modeling activities in which one represents the essence of a real-world system in the form of a computer model. These include simulations of traffic systems, queueing systems, production scheduling systems, hospital outpatient systems, etc. The models are developed as computer programs which are then executed on a digital computer. Because of the high calculation speeds of the digital computer, it is possible to "mimic" the actions of the real system using these models. Experiments which

evaluate alternative system designs and/or decision parameters can be conceived and tested in a relatively short period of time with neither the cost nor the disruption that would be incurred if the real system itself were used. The extensive literature in this area attests to the success and acceptance of this approach. A number of university courses have been developed to teach simulation as an analysis/ synthesis technique.

However, there has been little utilization of simulation as a pedagogical device; i.e., the use of simulation to aid in the teaching of some other subject rather than being the subject of instruction itself. The possible exception are management or business games. However, games do not contribute to the task of this research and are not further considered.

The area in which the pedagogical possibilities of simulation are beginning to be exploited are in the production-inventory area as illustrated for example by the simulator developed at Case Western Reserve University (ref. 7) and the PROSIM simulated developed at Auburn University (ref. 4 and 5). Students are presented with symptoms and data rather than well defined problems. The simulator is used by the students to diagnose the situation, formulate the problem, construct appropriate models, organize raw data and develop and experimentally test a solution. The purpose of the course in which such a simulator is used is to teach production and inventory control, not simulation.

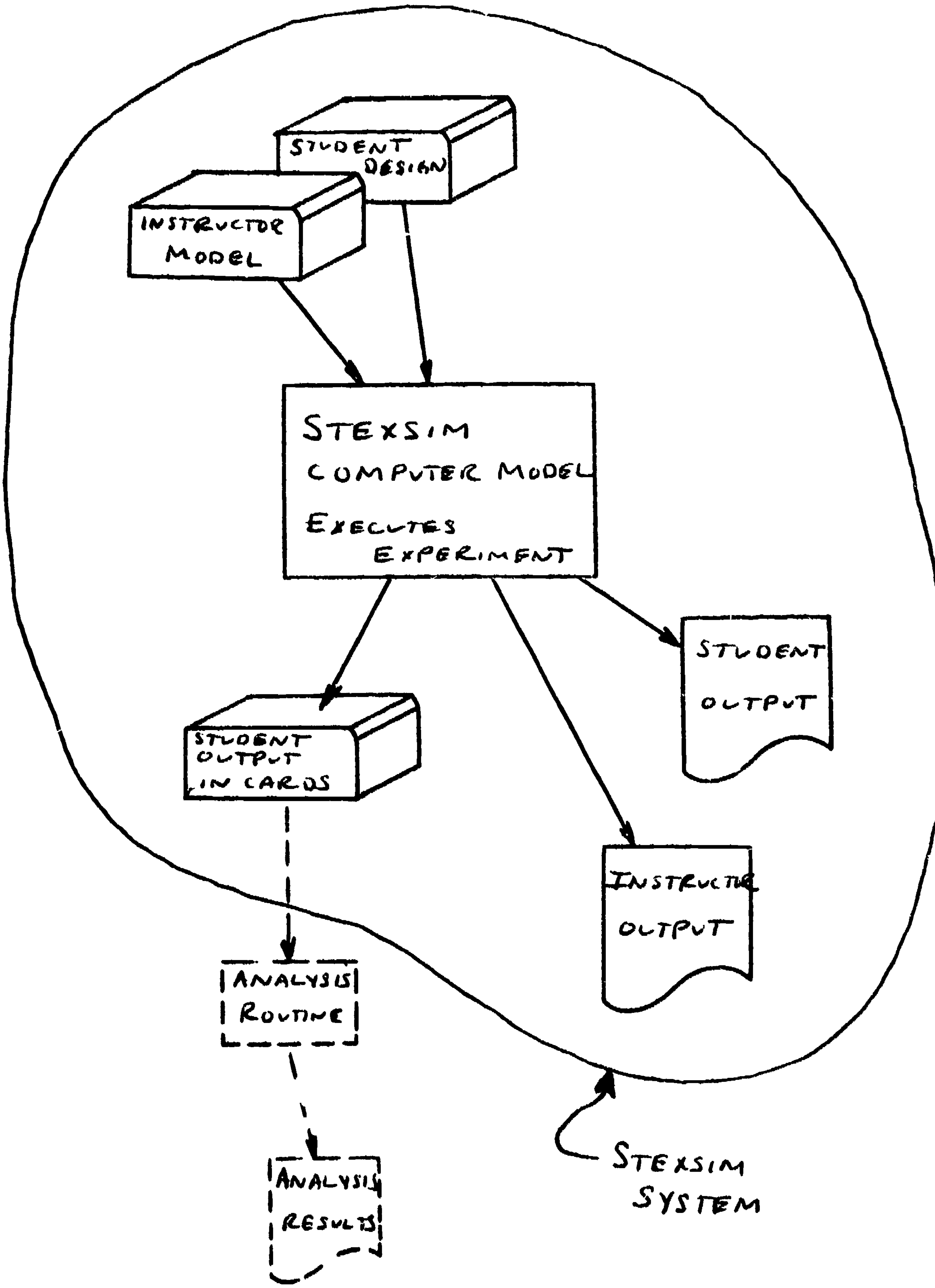
This research has taken an approach similar in philosophy but quite different in detail. A Statistical Experiment Simulator (STEXSIM) has been developed which permits an instructor to structure a problem environment and his students to examine this environment by means of sampling experiments which the students themselves design.

The process is shown graphically in Figure 1. The experimental environment is described to each student who then decides how he wishes to design an experiment from which he can draw inferences about the system being modeled. His design is entered in the form of punched cards to the STEXSIM computer model along with another punched card deck which defines the instructor's model. The student then receives output from the model which represents data that he would have received if he actually had run a real experiment. His results are given to him as a computer listing showing the "observation" resulting for each of the samples he has specified. If desired, the output is also prepared in punched card form which can be directly entered as data into a standard analysis computer routine from which he can draw the inferences he desires. Thus the student is able to participate in both the design and the analysis phases with STEXSIM providing the vital integrating role.

Furthermore, the model generating the student's data is completely under the control of the instructor who can interpret to the student the nature of his results. This complete knowledge of

Figure 1

Overview of Use of STEXSIM



the "true" model is a feature never present in real world experimentation and is therefore one of the more powerful features of the STEXSIM approach.

Because these experiments are accomplished in a very short period of time and at low cost, the student can be involved in the complete design-experiment-analysis process for a variety of problem situations. Through this process, it is anticipated that there will be improvement in both short term and long term retention of basic concepts and understanding of various statistical methodologies.

B. THE MODEL

The STEXSIM computer model is designed to handle problems which can be cast in the form of a completely crossed factorial model; i.e., each level of one factor can be combined with all levels of other factors. This permits use of the various analysis of variance of cross-classification designs including such incomplete factorial designs as Latin square, Graeco-Latin square and other fractional designs. The reader is assumed to be familiar with this area of experimental statistics as described for example in Johnson and Leone (ref. 3).

Up to seven main effects each at up to ten levels can be included. Three of these main effects (5, 6 and 7) may interact thus providing three possible two-factor interactions (5-6, 5-7 and 6-7) and one three-factor interaction (5-6-7). The non-interacting factors (1, 2, 3 and 4) generally serve the role of blocking factors whose effects are to be removed from the residual error but which are not of interest, per se, to the experimenter. However, there is no reason why any of these four cannot be factors of principle interest.

To produce a single observation, these main effects and interactions combine in a way depending on the instructor's model and student's experimental design. The instructor specifies his additive model while the student elects to use all or part of this model and specifies how the treatment levels of the various active factors are to be combined to generate an observation.

For purpose of understanding the approach, consider the basic additive model if there were only two active factors, A and B.

$$y_l = \mu + A_i + B_j + AB_{ij} + \epsilon_l$$

where μ = overall mean

A_i = incremental effect of ith level of factor A

B_j = incremental effect of jth level of factor B

AB_{ij} = incremental effect of interaction of A and B corresponding to level i of A and j of B

ϵ_l = residual error associated with the lth observation

y_l = lth observation of dependent variable y.

Certain commonly made assumptions underlie the philosophy of the STEXSIM model. If a factor is fixed the sum of the incremental effects for that factor must sum to zero. If, for example, factor

A is fixed

$$\sum_{\text{all } i} A_i = 0$$

If the experiment were repeated the same effects would be present since these are the only levels of interest.

On the other hand, if a factor is a random one, the various level effects entering a particular experiment are mutually independent random variables each selected from a normal distribution with expected value zero and variance σ^2. If the experiment were repeated a new set of effects would be present. For a particular experiment, once selected the effects do not change. If for example B were a random factor, the B_j's would be assumed to be random variables selected from a normal distribution with mean zero and variance σ_B^2 . However

$$\sum_{\text{all } j} B_j \neq 0$$

for the particular experiment since these are merely samples from a larger population.

Similarly for the two factor interaction, if both A and B are fixed factors, the incremental interaction effects do not change from experiment to experiment and

$$\sum_{\text{all } i,j} \sum AB_{ij} = 0.$$

On the other hand if either or both of the factors are random, the incremental effects are assumed mutually independent random variables selected from a normal distribution with mean zero and variance σ_{AB}^2.

To each observation is added a term representing the residual error ϵ_l associated with the lth observation. It accounts for the variability not otherwise accounted for by main effects and their interactions. Each is assumed to be a selection of a mutually independent normally distributed random variable with mean zero and variance σ_ϵ^2 .

While the assumptions of whether a factor is fixed or random has a significant effect on the analysis of an experiment, as far as STEXSIM is concerned, the only difference is in the manner in which the incremental effects are determined. STEXSIM's role is to generate "observations" each of which is comprised of the additive effects described above. When generating an observation STEXSIM needs to know only the incremental effect of each level of each active factor and interaction, but at that time is indifferent as to the <u>source</u> of those effects. These were defined earlier in the execution of the experiment in one of two way. If factor is fixed,

the incremental effects are defined explicitly by the instructor for each active level. If it is random the instructor specifies instead the standard deviation of the normal distribution (mean zero) from which incremental effects are sampled. This selection is done once per experiment remaining constant throughout that experiment once selected.

Similarly the incremental effects of an interaction of two or three factors all of which are fixed are specified explicitly by the instructor. If any of the factors are random, the instructor specifies instead the standard deviation of the normal distribution from which the selection is made.

Note carefully that the specification of incremental effects is the most significant feature of the STEXSIM approach. In "real world" experimentation these effects are not subject to the selection of anyone but rather are inherently present to be estimated and interpreted but not to be manipulated. In STEXSIM however they are all fully under the control of the instructor.

Consider now the full capability of STEXSIM. As described earlier an instructor can specify as active up to seven main effects (1,2,...,7) each of up to 10 levels (not necessarily the same for each factor). Furthermore two-factor interactions 5-6, 5-7 and 6-7 will be assumed present if both factors of the pair are active. Similarly the 5-6-7 three-way interaction will be active if these three factors are each active. Each of the seven factors declared as active must be further declared as fixed or random. If fixed the specific incremental treatment effects must be specified for all levels; if random, the standard deviation for the normal distribution from which the effects are to be sampled must be given. For the active interactions, specific incremental effects must be given if fixed; a standard deviation, if random or mixed.

In addition the instructor specifies the overall mean and the standard deviation of the normal distribution from which the residual error is to be selected.

A student specifies which factors he wishes to include and the treatment level of each comprising each observation. Each observation is computed from the additive model:

y_1 = overall mean

+ Σ (effects of specified level of each active main effect)

+ Σ (effects of any active two factor interaction)

+ (contribution from three factor interaction if active)

+ ϵ_1

In the event that a student has ignored a factor that actually is active, STEXSIM will generate random selections of levels of that factor for each observation of the student. This occurs for example when a student ignores a blocking factor thereby confounding that factor's effect with the error term. The student would observe an inflated error term. This is analogous to what happens in actual experimentation when an important factor is omitted from a design.

Once an experiment has been "run," STEXSIM transfers control to a report generator routine which provides extensive output to the student and his instructor describing the experiment that has been completed.

C. OVERVIEW OF REPORT

Section III describes in detail the STEXSIM model including the functions of various computer subroutines, how to input information to the model and how to interpret the output generated by the model. Section IV presents a demonstration of the use of STEXSIM for seven different "instructor" models and a total of 30 "student" experimental designs using these models. The results of these experiments are analyzed and discussed. Section V provides a summary of conclusions for this project and points the way towards the future research presently being planned.

The appendices contain a listing of the STEXSIM computer program plus detailed input and output for each of the experiments and results of the analyses of variance.

III. DESCRIPTION OF STEXSIM MODEL

A. MODEL DESIGN

The basic STEXSIM model is composed of a main program MONITOR which calls on any of six subroutines and two functions in the course of executing each student's experimental design. The entire model is written in the Fortran IV programming language for execution on the CDC 6400 computer at the State University of New York at Buffalo.

It is the objective of this section to describe in general for each of the several routines, its function, the conditions under which it is called and the information communicated to and returned from the routine.Appendix A summarizes the definition of each key variable while Appendix B provides a complete Fortran IV program listing. Flow charts are provided for MONITOR and each subroutine.

1. Main Program MONITOR

   a. Purpose: MONITOR provides overall control of the execution of STEXSIM. It causes an instructor's model to be read followed by the specified number of student "experiments." For each such experiment a variety of experiment definition tasks are accomplished after which the requisite number of observations are generated for transmission to the OUTPUT program. All input to any phase of STEXSIM is via MONITOR. Similarly, any subroutine is called only by MONITOR, never any other subroutine. Therefore MONITOR is central to the sequence of execution of STEXSIM.

   b. Input:

   From punched cards: See input specifications in Section IIIB.

   c. Output:

   Since all subroutines are called by MONITOR, see the input specifications for each such subroutine.

   d. Procedure: The general sequence of activity is that the instructor's model is read in (the contents for which are specified in Section IIIB) followed by a set of student experiments (contents also specified in Section IIIB). Depending on the nature of the experiments, subroutines LEVSEL, RTRT, RINTER may be called. TRADJ will then be called for each experiment. Finally for each observation requested AMEAN will be called to create the deterministic component of the observation. Once the experiment has been

executed the results are punched and printed by subroutine OUTPUT. When the last student's experiment has been completed, a new instructor model, if any, is read. Figure 2 shows a flow chart of the logic flow in MONITOR while the program can be found in Appendix B .

2. Subroutine TRADJ

a. Purpose: Subroutine TRADJ is called by MONITOR exactly once for each student experiment. When a student requests for a fixed factor a fewer number of levels than provided by the instructor, an adjustment is made of the overall mean and various treatment effects in order to insure a zero sum of the "true" effects of the treatments included by the student. This in no way affects the value of the dependent variable, y, that is generated but is provided to the instructor in his detailed output solely in order that he might have information as to the exact values of mean and treatment effects being estimated by the student.

b. Input:

By argument: FMU

by common: IACT(7),IFLAG(7),LI(7),LS(7),AI(7,10), LEV(I,K),BI(3,10,10),CI(10,10,10)

c. Output:

By argument: IOUT,FMSS

By common: AS(7,10),BS(3,10,10),CS(10,10,10)

d. Procedure: The general logic is described in the flow chart of Figure 3 . An adjustment of the overall mean and incremental main factor treatment effects is made when the factor is fixed and the student requests fewer levels than provided by the instructor. Similarly for the possible two factor interactions an adjustment is made when both factors entering the interaction are fixed and active and the student requests for one or both a number of levels less than provided by the instructor. In like manner an adjustment is made for the three factor interaction if required. If for any fixed active factor the student maximum level (LS(I)) exceeds the instructor level (LI(I)), the variable IOUT is set equal to 2 and an error return occurs. Upon return to MONITOR this will cause the termination of the execution of the particular student experiment in which it occurred.

3. Subroutine LEVSEL

a. Purpose: Subroutine LEVSEL is called by MONITOR whenever a

Figure 2

Main Program MONITOR

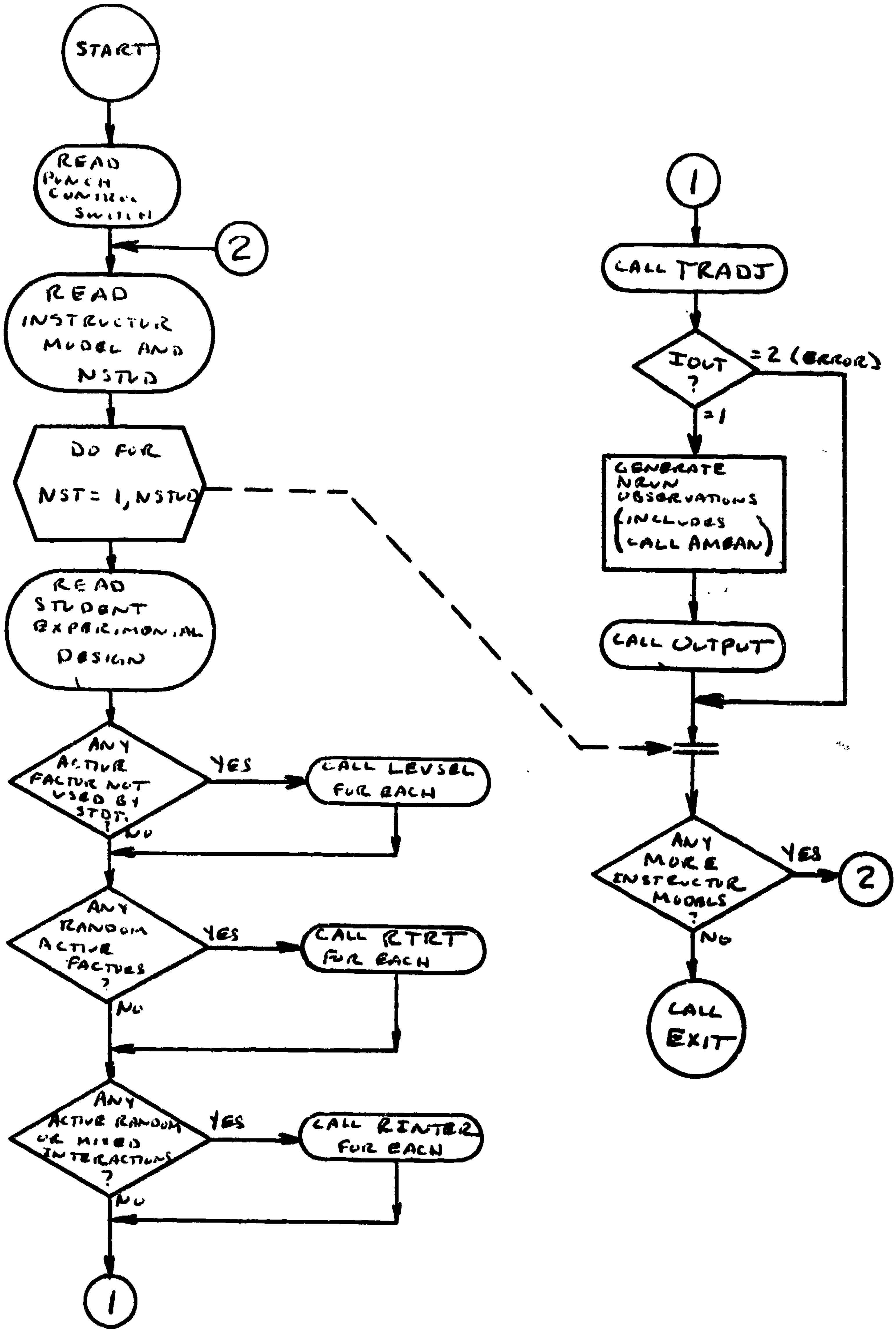
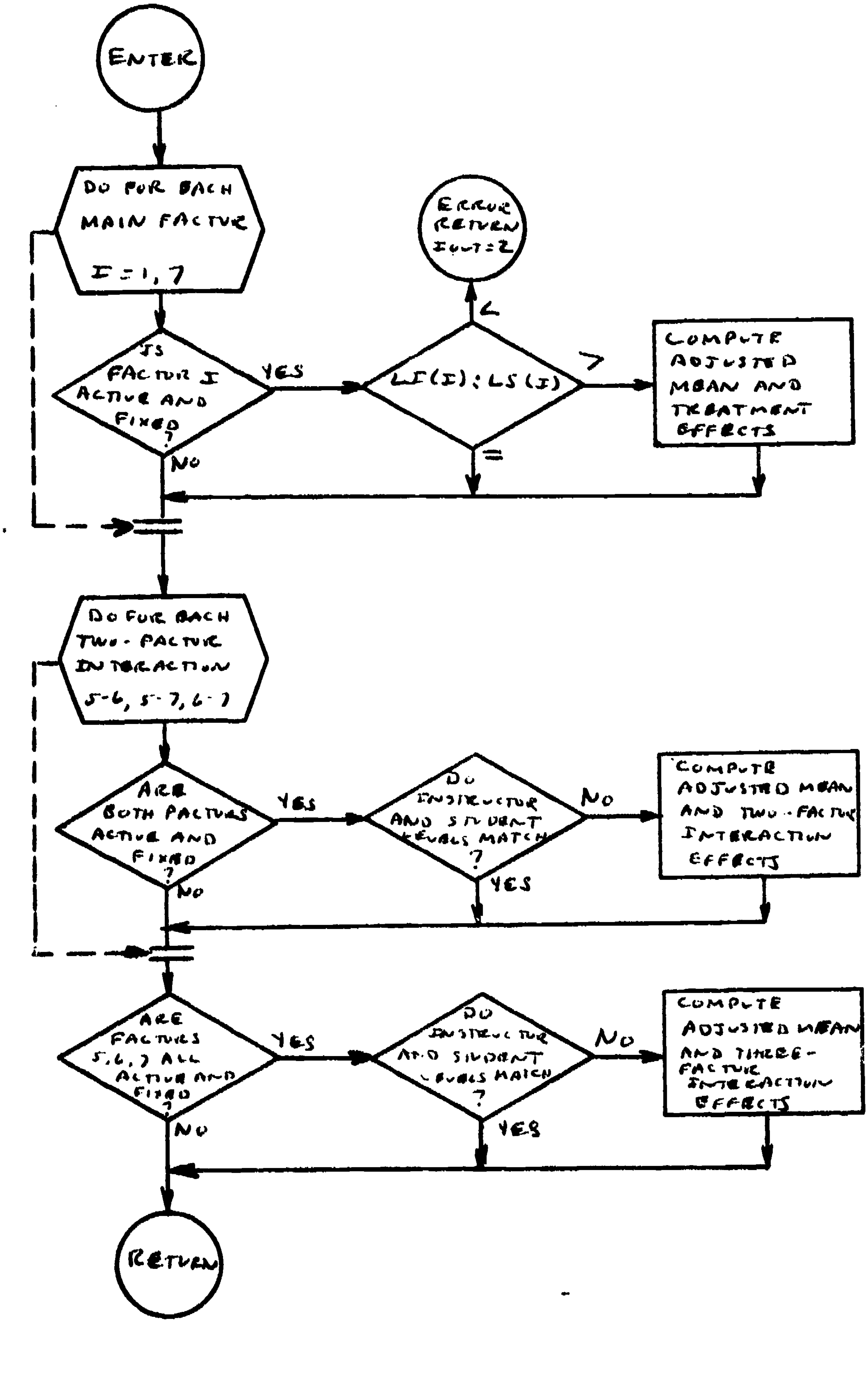


Figure 3

Subroutine TRADJ



factor (fixed or random), specified by the instructor as active, is declared inactive by the student. For each observation of the student the subroutine will assign for each such factor a level selected randomly from the interval 1 to the number of levels specified by the instructor. This selection will not be known to the student but will be printed for the instructor. As whenever an experimenter fails to include in his design a relevant factor, this selection will not be measurable by the student but rather contributes to the residual mean square in his analysis.

b. Input:

By argument: J,NRUN

By common: LI(7),LEV(7,10)

c. Output:

By argument: none

By common: IW(200,7),LEV(7,10),LS(7)

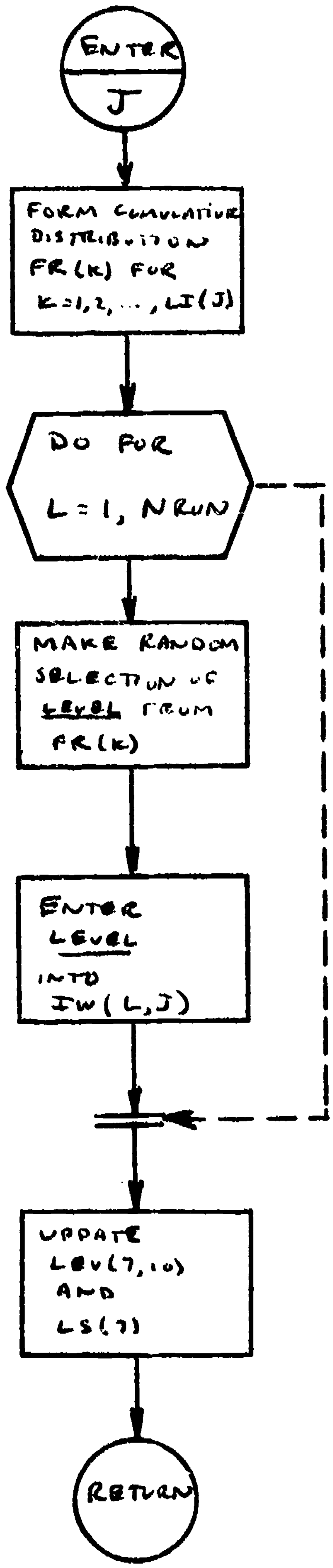
d. Procedure: For factor J for which the subroutine is entered an equally probable random selection is made from the set of integer values, 1,2,...,LI(J). This selection made once for each of the NRUN observations requested by the student is entered into IW(200,7) which contains the treatment levels for each of 7 main effects for each of the NRUN (≤ 200) observations. An error message is printed if for some reason a level selection is not successful; the level is set at 10 and execution continues. The seed number for the random number generator used in this subroutine is defined within and used exclusively for this subroutine. Figure 4 contains a flow chart for this subroutine.

4. Subroutine RTRT

a. Purpose: For every main factor declared random by the instructor, subroutine RTRT is called by MONITOR to select the treatment effects which are used in the student's experiment. These effects remain constant for the duration of a student's experiment. A new student's experiment will, however, receive a new (and presumably different) selection of treatment effects. The standard deviation of the normal distribution from which the selection is made is specified in the instructor's model. Subroutine RTRT is entered whether or not the student has declared the factor active. In the latter case LEVSEL would have first been entered.

Figure 4

Subroutine LEVSEL



b. Input:

By argument: J

By common: LI(7),STD(J),FLIM(11,2)

c. Output:

By argument: none

By common: AI(7,10)

d. Procedure: One selection is made for each of the LI(J) active levels of factor J. Each selection is made randomly from a normal distribution with mean zero and standard deviation, STD(J). Any sample not within the minimum and maximum specified by the instructor (KLIM(J,1) and KLIM(J,2)) is rejected and another selection made. In the event that an acceptable sample is not generated in 1000 trials an error message is printed and execution returned to MONITOR. The seed number for the random number generator used in RTRT is defined within and used exclusively for this subroutine. Figure 5 contains a flow chart for this routine.

5. Subroutine RINTER

a. Purpose: Subroutine RINTER is called by MONITOR for each active two factor interaction (5-6,5-7,6-7) and the three factor interaction (5-6-7) if any of the factors are random, i.e., it is entered for mixed and random models. Its function is identical to that of RTRT except the number of treatment effects selected equals the product of the number of levels of each factor involved in the particular interaction.

b. Input:

By argument: K

By common: LI(7),STD(J),FLIM(11,2)

c. Output:

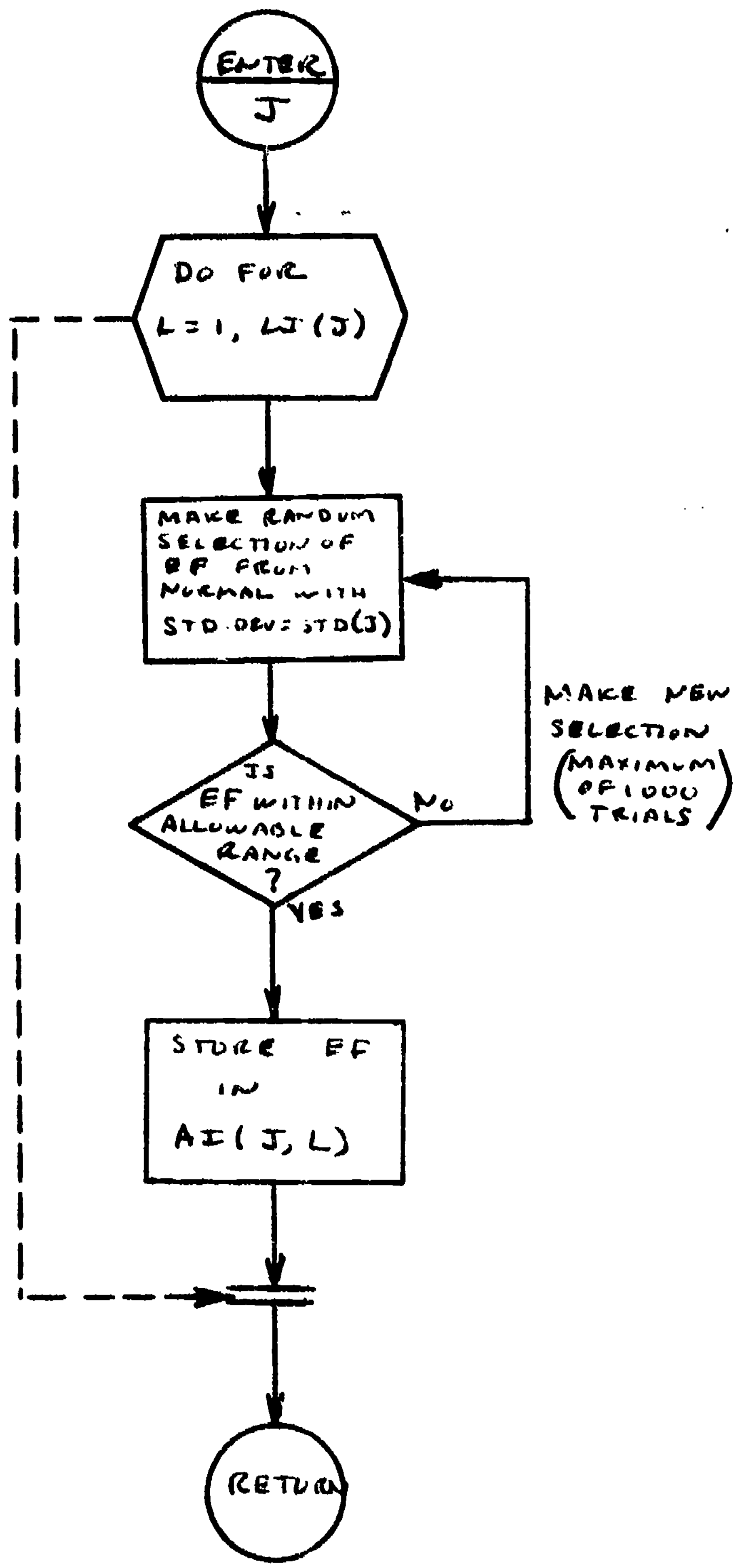
By argument: none

By common: BI(3,10,10),CI(10,10,10)

d. Procedure: K determines the interaction being considered.

Figure 5

Subroutine RTRT



K	interaction
8	5-6
9	5-7
10	6-7
11	5-6-7

For the two factor interaction I-J(K=8,9,10),LI(I)*LI(J) selections are made from a normal distribution with mean zero and standard deviation STD(K). For the three factor interaction (K=11),LI(5)*LI(6)*LI(7) selections are made from a normal distribution with STD(11). As in RTRT a selection is rejected if it does not fall within the range specified by the instructor (KLIM(K,1) to KLIM(K,2)). The seed number for the random number generator used in RINTER is defined within and used exclusively for this subroutine. The flow chart for this subroutine can be found in Figure 6 .

6. Subroutine AMEAN

a. Purpose: Subroutine AMEAN is called by MONITOR once for each of the NRUN observations requested by the student. This routine generates the portion of each dependent variable before the error component is added. It adds to the overall mean the specific treatment effects for the levels of each factor that comprise each observation (specified by student or generated in LEVSEL).

b. Input:

By argument: L(observation index),FMU

By common: IACT(7),IW(200,7),AI(7,10),BI(3,10,10), CI(10,10,10)

c. Output:

By argument: FMS

By common: none

d. Procedure: This subroutine proceeds by first setting FMS equal to the overall mean, FMU, and then adding to it the appropriate incremental treatment effects of each active main effect factor and active interaction. The flow chart is shown in Figure 7 .

7. Subroutine OUTPUT

a. Purpose: Subroutine OUTPUT is called by MONITOR after all requested observations are generated in order to print out

Figure 6

Subroutine RINTER

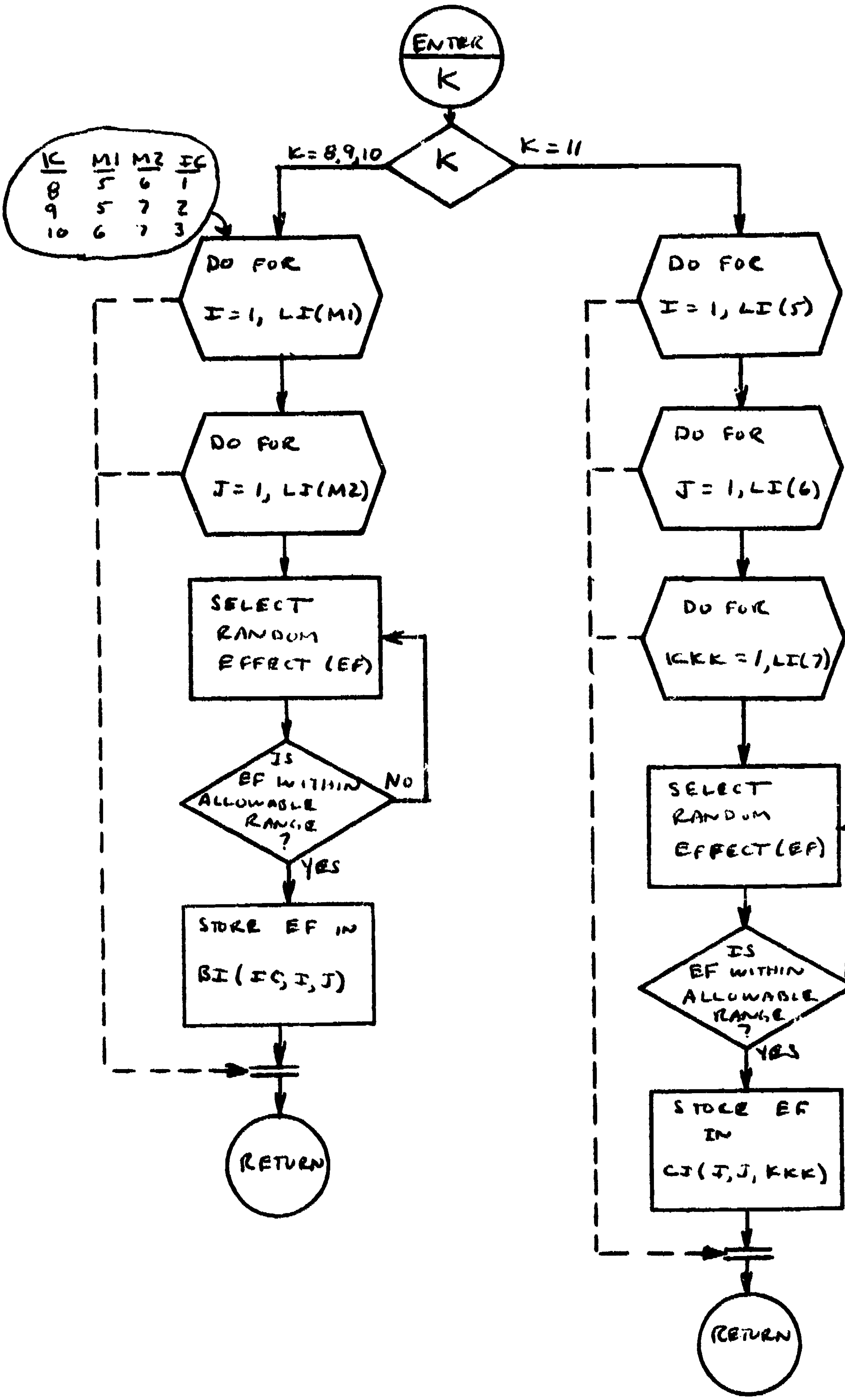
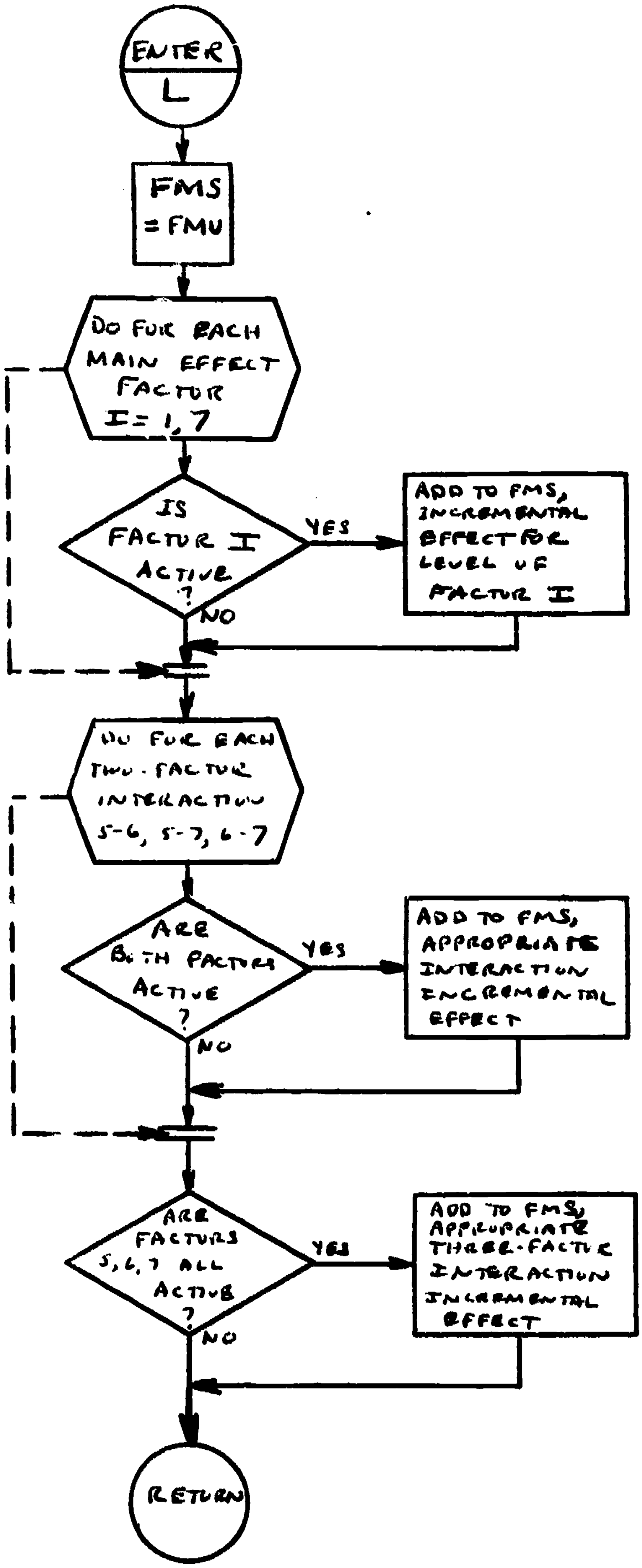


Figure 7

Subroutine AMEAN



results and, if requested, to punch out a card deck of experimental results.

b. Input:

By argument: NST,NRUN,FMU,FMSS

By common: PUNSW,YD(200),IW1(200,7),NAME(80),ISW, IW(200,7),IACT(7),IFLAG(7),LI(7),INCLD(7), KEY(7),LS(7),LEV(7,10),AI(7,10),BI(3,10,10), CI(10,10,10),SIGMA,AS(7,10)

c. Output: (not including punched and printed output)

By argument: none

By common: none

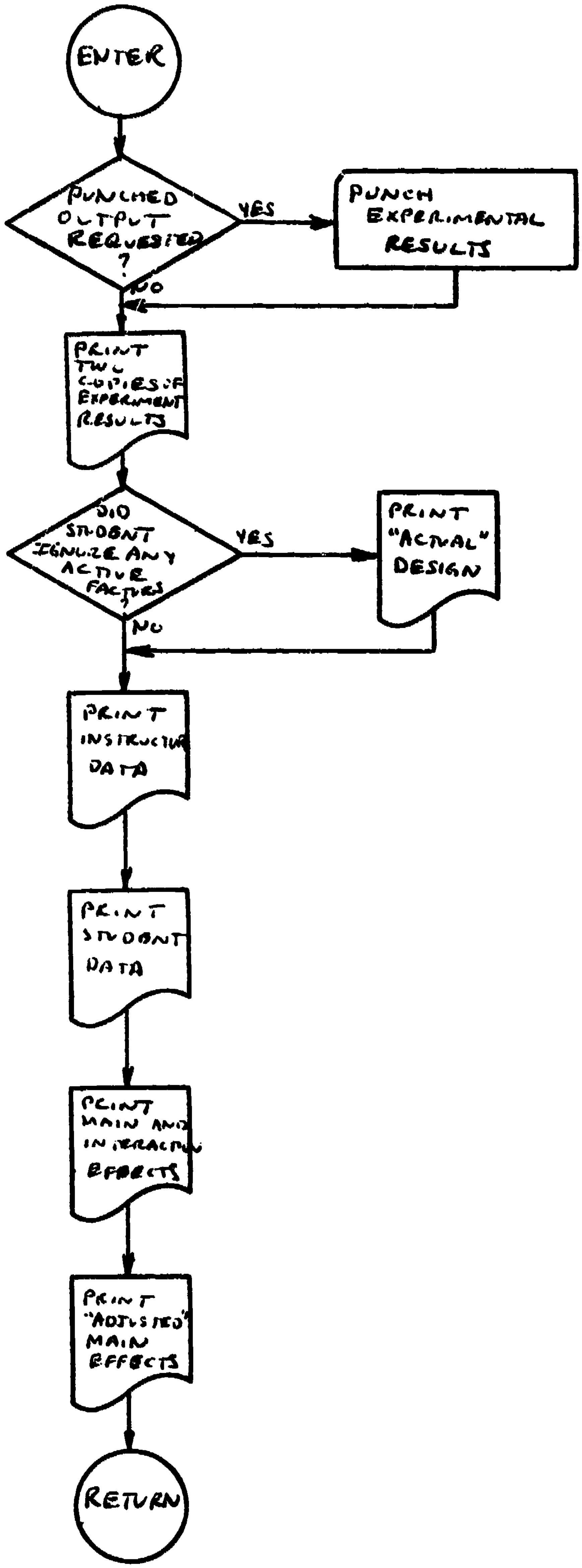
d. Procedure: No calculations are made in this subroutine. Rather it is devoted exclusively to the punching and printing of results for a single student's experiment. Punching is controlled by the first data card of the instructor's model. If it contained the word PUNCH, punching is accomplished; if any other alphanumeric quantity, punching is bypassed. The punched deck with one card per observation can be used by the student as data input to a computer analysis routine. One section is printed to be given to the student showing for each requested observation, the factor levels requested and the resultant dependent variable. Levels selected by LEVSEL for active factors ignored by student are not shown. A second section is printed for the instructor listing the same information prepared for the student plus extensive information for the instructor as to various model conditions entering into the generation of the student's observations including factors selected by LEVSEL, treatment effects for active fixed and random factors, etc. The output format is described in detail in Section IIIC. A flow chart of this subroutine is in Figure 8 .

8. Function FNORM

a. Purpose: Function FNORM provides a single random selection from a normal distribution with mean zero and standard deviation SIGMA utilizing as the seed variable NSEED. It is called for each observation by MONITOR in order to provide the residual error component. It is also called by RTRT and RINTER to provide selections of treatment effects for random factors and random and mixed interactions.

Figure 8

Subroutine OUTPUT



b. Input:

By argument: SIGMA,NSEED

By common: none

c. Output:

By function name: FNORM

By argument: NSEED

By common: none

d. Procedure: The method used for the generation of normal variates is that attributed to Box and Muller (ref. 1). No flow chart is required. The program is listed however in Appendix B .

9. Function RND:

a. Purpose: Function RND provides a sample from a distribution uniformly distributed on the interval 0 to 1.0. It is called whenever a random number is required either directly (as in LEVSEL) or for transformation to another variate of interest (as FNORM).

b. Input:

By argument: NSEED

By common: none

c. Output:

By function name: RND

By argument: NSEED

By common: none

d. Procedure: The method used is the commonly used multiplicative congruential method (as discussed for example in Naylar et al, ref. 6). NSEED is multiplied by a constant to provide an integer value which is then scaled by 2^{-48} in order to provide a value in the unit interval. The integer result of this multiplication becomes the new value of NSEED which is returned to the calling routine. In this way independent random number streams can be provided to each of any number of calling routines.

CAUTION: This routine is machine dependent as are all pseudo random number generators in use today. This particular routine was developed by the principle investigator for the CDC 6400 computer at the State University of New York at Buffalo. Hence it will operate satisfactorily only on this machine which, although having 60 bit word, is effectively a 48 bit one because of the manner in which fixed point multiplications are accomplished. Therefore, this routine must be replaced by one appropriate for the local implementation of STEXSIM.

B. INPUT SPECIFICATIONS

Input to STEXSIM includes a set of cards (Set A) provided by the instructor to define the statistical model and to specify certain other run defining variables. This set is followed by one set (Set B) for each student's experimental design to be run utilizing the statistical model of Set A. Up to 99 student designs can be run sequentially for a given model. Any number of models may be stacked to run sequentially. Each Set A will be followed by as many (≤ 99) student designs (Set B) as desired. Any model of up to 7 fixed or random factors each with up to 10 levels may be defined in card Set A. The STEXSIM computer model itself need never be altered; all changes are made via data cards. Reference to the sample input listing in Appendix C should help clarify the specifications below.

1. PUNCH CONTROL

To provide control over the punching of output the first data card must contain either of the following words commencing in card column 1

PUNCH
NO PUNCH

In the case of PUNCH, each student's output will be provided in punched card as well as printed form. If NO PUNCH, only printed output will be provided. An appropriate message is printed on the output sheets so that the student will know whether or not he should expect punched output. A single punch control card controls punching for the entire run of STEXSIM, i.e. it cannot be changed from one model to another executed in a single computer run.

2. INSTRUCTOR SET A

For each model, the instructor provides the following set of cards in the order presented.

Card 1 - Model definition card

There must be exactly one card type 1 containing the following information.

a. Columns 1 to 7 specify which factors are active.

Column	Factor
1	1
2	2
3	3
4	4
5	5
6	6
7	7

In each column a

1 denotes an active factor and a
2 denotes an inactive factor.

These are read with 7I1 format into IACT(I),I=1,7.

b. Columns 8 to 14 specify whether each factor is fixed or random.

Column	Factor
8	1
9	2
10	3
11	4
12	5
13	6
14	7

In each column enter a

1 if the corresponding factor is fixed
2 if it is random or if it is not active.

These are read under 7I1 format into IFLAG(I),I=1,7.

c. Columns 15 to 28 specify the number of levels of each of the active factors. Each factor can have a maximum of 10 levels.

Columns	Factor
15-16	1
17-18	2
19-20	3
21-22	4
23-24	5
25-26	6
27-28	7

The integer number of levels should be right justified within the appropriate two column field. For inactive factors blanks or any numeric quantity may be specified.

These are read in 7I2 format into LI(I),I=1,7.

d. In columns 29 to 38 the overall mean is entered. This quantity is read into variable FMU using an F10.4 format. If the decimal point is punched in the card, the field may fall anywhere within columns 29 to 38. Otherwise the F10.4 format must be strictly adhered to.

e. Card columns 39-40 specify how many student designs (Sets B) follow this Set A. The quantity must be integer and right justified. (It is read with I2 format into NSTUD).

The information on this card defines which of card types 3

through 8 will next be read.

Card type 2 - Fixed main effect

There will be one card type 3 for each active main effect factor which is fixed. These cards are arranged in increasing order of factor index I (I = 1,2,..,7). Within a card, the incremental effects for that factor are entered in 10F8.4 format.

Columns	Effects for level
1-8	1
9-16	2
17-24	3
25-32	4
33-40	5
41-48	6
49-56	7
57-64	8
65-72	9
73-80	10

If the decimal point is punched, entries may be anywhere within the appropriate 8 column field. Otherwise, the F8.4 format must be strictly adhered to.

These are read into AI(I,J),J=1,LI(I)

Statistical theory requires

$$\sum_{J=1}^{LI(I)} AI(I,J) = 0 \qquad \text{for all I}$$

Card type 3 - Fixed two factor interaction

There will be one set of cards type 3 for each interaction of two fixed main effect factors. Since Factors 5, 6 and 7 are the only factors which may interact, the only two factor interactions possible are 5-6, 5-7 and 6-7. STEXSIM will read sets of type 4 cards whenever both main effects of each of these three possibilities is active. Even if one of these interaction effects is not desired, if the two factors (5, 6 or 7) making it up are active, type 4 cards will be read in which case zeroes must be entered.

For interaction I,J (I,J=5,6,7;I≠J) provide one card for each level of factor I. On each card enter in 10F8.4 format the incremental effects corresponding to each of the levels of factor J. Hence, there will be LI(I) cards each with LI(J) entries for interaction I,J.

This is repeated for each of the interactions 5-6, 5-7, and 6-7 in that order when active. Note that the summation over levels of I for a particular level of J must equal one as must the summation over levels of J for a particular level of I.

This data is read into BI(IC,L3,L4),L4=1,LI(J);L3=1,LI(I) where

IC = 1 if I=5, J=6
 2 " I=5, J=7
 3 " I=6, J=7

Card type 4 - Fixed three factor interaction

There will be at most one fixed three factor interaction which occurs only when factors 5, 6 and 7 are each active and fixed. Each entry on the data cards is the incremental effect corresponding to each combination of levels of factors 5, 6 and 7. There must be one card for each combination of levels of factors 5 and 6. Letting L_5 denote level of factor 5 and L_6 levels of factor 6, these cards are in order of L_6 indexing within index L_5 (i.e. 1-1, 1-2, 1-3, 2-1, 2-2 etc.). There will be LI(5)*LI(6) data cards each containing LI(7) entries. Each such entry represents the increment effect corresponding to the L_7'th effect of factor 7, L_5'th of 5 and L_6'th of 6. This data must be in F8.4 format.

This data is read into CI(L1,L2,L3),L3=1,LI(7)
L1=1,LI(5) and
L2=1,LI(6).

Statistical theory requires zero summation over any index of CI for each combination of all levels of the other two.

STEXSIM will read LI(5)*LI(6) data cards.

Card type 5 - Random main effect

There will be one card type 5 for each random main effect I, I=1,...,7. Each contains three quantities.

Column	Content
1-8	FLIM(I,1)
9-16	FLIM(I,2)
17-24	STD(I)

read in 3F8.4 format.

STD(I) is the standard deviation corresponding to factor I. These are used at the time of selecting the set of treatment effects for a particular student's experimental design. The effects, for as many levels as requested by the student, are selected from a normal distribution with expected value zero and standard deviation STD(I).

FLIM(I,1) is the lowest allowable value of each treatment effect for factor I while FLIM(I,2) is the upper limit. Any selection from the normal distribution which does not fall within these inclusive limits is discarded. This provides a means for preventing extreme values from contaminating an experiment.

These cards are to be in order of index I (1,2,...,7).

Card type 6 - Random or mixed two factor interaction

One card must be provided for each active two factor interaction where both factors are random (random model) or where one is fixed and one random (mixed model). The content and format is identi to that of card type 5; namely

Column	Content
1-8	FLIM(I,1)
9-16	FLIM(I,2)
17-24	STD(I)

read in 3F8.4 format where

I = 8 if factor 5 and 6 both active and at least one is random
I = 9 " " 5 " 7 " " " " " " " "
I = 10 " " 6 " 7 " " " " " " " "

These cards, if present, are to be in the above order.

Card type 7 - Random or mixed three factor interaction

There will be exactly one card of type 7 if and only if factors 5, 6 and 7 are all active and at least one is random. The format is identical to card types 5 and 6 with I=11.

Card 8 - Error definition card

There must be exactly one card type 8.

a. In column 1-8 in F8.4 format the error standard deviation (SIGMA) is punched. In arriving at a particular observation requested by a student, to the sum of various incremental additive effects (main and interaction), there is added a variate selected from a normal distribution with mean zero and standard deviation, SIGMA.

b. Column 9-16 contain the seed number for the random number generator which generates the error deviates. This quantity is read into NSEED. Since it is read in I10 format this quantity should be right justified.

The occurrence of this card denotes the end of the set of cards defining the instructor's model (Set A). Following this are NSTUD sets of Set B defining each student's experimental design.

3. STUDENT SET B

Each student's experimental design is comprised of the following cards.

Card 1 - Identification

The first card of each student Set B is an identification card. All information in columns 1-80 is printed on the output reports and is punched in the corresponding punched output deck to provide identification information. Exactly one card must be provided.

Card 2 - Design definition card

There will be exactly one card type 2 defining the nature of the student's design.

a. Columns 1 to 7 specify which factors are active.

Column	Factor
1	1
2	2
3	3
4	4
5	5
6	6
7	7

In each column a

1 denotes a factor included in the student's design
2 denotes a factor that is not included.

These are read with 7I1 format into INCLD(I),I=1,7.

b. Columns 8 to 14 specify whether the student deems each main effect factor active or random.

Column	Factor
8	1
9	2
10	3
11	4
12	5
13	6
14	7

Enter in each column a

1 if the corresponding factor is considered fixed
2 if the factor is assumed random or if it is not active.

These are read in 7I1 format into KEY(I),I=1,7. Note that this variable is used solely to print out the student's assumption but does not affect the execution of the model in any way.

c. Enter right justified in columns 15-19 the number of observations which are requested. This is read in I4 format into variable NRUN. NRUN must not exceed 200.

Card type 3 - Factor level definition

There will be one card for each main effect factor actively entering the student's design. There is one card for each factor used by the student whether or not that factor is defined by the instructor as active. These are to be ordered in sequence of increasing factor identification I,I=1,7.

Column 1-2 contains (in I2 format) the number of levels of the corresponding factor I which is read into LS(I). The next LS(I) two digit columns contain the identification of each of these LS(I) levels. This defines the levels which will be encountered on the observation definition cards (type 4). These entries must be right justified.

Column	Identification of level
3-4	1
5-6	2
7-8	3
9-10	4
11-12	5
13-14	6
15-16	7
17-18	8
19-20	9
21-22	10

Only the first LS(I) levels should be defined.
These are read into LEV(I,J),J=1,LS(I).

If student specifies more levels than does the instructor (LS(I) > LI(I)) and if the instructor defines factor I as fixed, an error will be generated and the execution of this student's design will be aborted.

Card type 4 - Observation definition card

There must be NRUN (specified on card 2) observation definition cards. Each card defines for each observation the levels of each of the factors deemed active by the student.

Column	Levels for factor
1-2	1
3-4	2
5-6	3
7-8	4
9-10	5
11-12	6
13-14	7

These are read in 7I2 format (and hence must be right justified) into variable

$$IW1(L,I) \quad \text{for} \quad I=1,7 \text{ and } L=1,NRUN$$

$$IW1(L,I) \leq LS(I)$$

One observation of the dependent variable is generated by STEXSIM for each observation requested by a definition card. These observations are generated from the levels of the independent variables (factors) requested on that card. These cards should be in the sequence in which the student wishes to obtain his observations. This is the point at which randomization should enter. There must be exactly NRUN type 4 cards.

C. OUTPUT INTERPRETATION

Upon completion of execution of each student "experiment" STEXSIM produces two sets of output, one set for the student and one for his instructor.

1. OUTPUT FOR STUDENT

The student is provided with a printout showing for each observation he has requested the levels of each of the factors he has declared active (this is taken directly from the student's input deck) and the resultant observation generated by STEXSIM. His output sheet will be headed by a label containing the information in the student's identification card (card 1). Appendix D1 contains a typical such listing. This listing includes explanatory comments. In this case the error variance is set equal to zero so that one can observe the additive nature of the model.

If requested by the instructor's PUNCH control card, the same information is provided in punched card form. The statement PUNCHED OUTPUT SPECIFIED at the end of the printed output will alert the student to the existence of a punched deck. This deck is headed by one card containing the identification card contents and a second with a sequence number. Each experimental observation is on a single card in the following format.

Col	Content	Format
1-10	observation	F10.4
11-14	level for factor 1	I4
15-18	" " " 2	I4
19-22	" " " 3	I4
23-26	" " " 4	I4
27-30	" " " 5	I4
31-34	" " " 6	I4
35-38	" " " 7	I4

These cards can be arranged in any desired order to satisfy input specifications for any analysis routine that might be used to conduct the final analysis of variance of this data.

It should be noted that the student obtains information only as to the levels used of factors he has defined as active. Levels generated by LEVSEL for ignored active factors are given only to the instructor.

2. OUTPUT FOR INSTRUCTOR

The instructor is provided with an identical copy of the information provided to the student. In addition he receives extensive additional information as to the exact model underlying the experimental results generated for the student. A typical such output annoted with explanatory comments is included as Appendix D2.

In the event that the student has ignored an active factor, a second listing provides the instructor with complete knowledge of which levels of each factor enter in the calculation of each observation including those selected by LEVSEL.

Next for each of the 7 factors the instructor's definition as to which are active; if active, whether fixed or random and the number of levels is printed. This is followed by the comparable information from the student's design. The student's specification of fixed/random in no way affects the execution of STEXSIM but is provided merely for information for the instructor.

Following these, the overall mean as specified by the instructor is printed along with a "student value" which is the overall mean corrected (by TRADJ) for treatment levels of fixed factors which have not been used. This would be the "true" value being estimated by the particular student.

The incremental treatment effects for active main factors and all active interactions are printed next. For fixed main effects or fixed interactions these are the specific values entered by the instructor and would be the same for any student using the particular model. However, for random main effects or random or mixed interactions these are the results of the random selection made in RTRT or RINTER. While they remain constant for the duration of the student's experiment, a new selection is made for the experiment of the next student.

The standard deviation for the residual error component is next printed. It is followed by a listing of the adjusted treatment effects for each of the seven main factors. These will differ from the values specified by the instructor if a student has used fewer levels of a fixed active factor than are provided by the instructor. This adjustment (accomplished in TRADJ) is compensated in the "student value" of the overall mean printed earlier.

The purpose of this added information for the instructor is to assist him in interpreting to the student the model underlying the generation of the observations he receives. This is the type of information never available in real world experimentation and is, therefore, one of the most valuable aspects of the STEXSIM approach to teaching experimental statistics.

IV. EXPERIMENTAL USE OF SIMULATOR

A. DESCRIPTION OF EXPERIMENTS

In order to test the model and demonstrate its versatility, 7 different "instructor" models have been formulated. These have been tested by running several "student" experimental designs for each instructor model. A total of 30 experiments have been executed. These are identified in this section. The input for each instructor model and student design are listed in Appendix E along with the STEXSIM results for each and an analysis of variance run on the resultant generated data in Appendices E and F respectively.

1. MODEL 1: To test a non-interacting two factor fixed model, factor 1 is active, fixed with 5 levels while factor 2 is active, fixed with 4 levels.

   a. EXPERIMENT 1A: The student specifies the same model as the instructor with one observation per cell for a total of 20 observations.

   b. EXPERIMENT 1B: The student again matches the instructor's model but with 40 observations in order to show how replication improves the power of design by providing additional residual degrees of freedom (40 observations).

   c. EXPERIMENT 1C: This experiment is the same as 1B except three observations per cell are requested (60 observations).

   d. EXPERIMENT 1D: In this design the student requests 5 levels of factor 1 but uses 4 levels of factor 3 (which is inactive) and ignores active factor 2. STEXSIM will generate random selection of levels of factor 2. There is one observation per cell (20 observations).

   e. EXPERIMENT 1E: The student in this design specifies three levels of factor 1, 2 and 3 to demonstrate that he may specify fewer levels than instructor. Factor 3 will not contribute. One observation per cell is requested (27 observations).

   f. EXPERIMENT 1F: Factors 1 and 2 are ignored completely while 4 levels are requested of factors 5 and 6. STEXSIM will randomly select levels of factors 1 and 2 for each observation (16 observations).

2. MODEL 2: Instructor model 2 provides a test of a fixed two factor interacting experimental situation. Factor 5 is fixed with 6 levels while factor 6 is fixed at 4 levels. All other factors are inactive.

a. EXPERIMENT 2A: The student specifies the same model as the instructor with one observation per cell (24 observations).

b. EXPERIMENT 2B: Same as experiment 2A except two observations per cell in order to make a direct main effects test (48 observations).

c. EXPERIMENT 2C: Same experiment as 2A except three observations per cell (22 observations).

d. EXPERIMENT 2D: Same as 2A except four observations per cell to demonstrate improved power of design which has more replications (96 observations).

e. EXPERIMENT 2E: Student ignores factor 6 while using only 4 levels of factor 5. Student runs a one-way design with five observations per treatment. STEXSIM generates levels of factor 6 (20 observations).

3. MODEL 3: Model 3 demonstrates the role of blocking in reducing the error means square in order to improve the precision of the test. To accomplish this model 2 is used with the addition of blocking factor 1 being entered as a random factor.

   a. EXPERIMENT 3A: The student ignores factor 1 (blocking factor) using two observations per cell of each of the 24 treatment combinations of 6 levels of factor 5 and 4 of factor 6 (48 observations).

   b. EXPERIMENT 3B: In this design, blocking factor 1 is utilized at two levels. There is one observation per each of the 48 cells (2 x 24) which is equivalent to partitioning the two observations per cell of experiment 3A into one from level 1 and one from level 2 of factor 1 (48 observations).

4. MODEL 4: This model provides a test of STEXSIM in simulating a fixed three factor interaction experimental situation. Each of factors 5, 6 and 7 is fixed at 3 levels each. Interactions 5-6, 5-7, 6-7 and 5-6-7 are each defined.

   a. EXPERIMENT 4A: The student's design matches the instructor's model with one observation per cell. The three factor interaction must be assumed zero since it cannot be separated from the error mean square (27 observations).

   b. EXPERIMENT 4B: This experiment also matches the instructor's model but utilizes two observations per cell. The presence of three factor interaction can now be tested since replication provides a separate error measure (54 observations).

c. EXPERIMENT 4C: The student in this design assumes factor 1 (at 2 levels), 6 (at 3) and 7 (at 3) rather than 5, 6 and 7 active. There are two observations per treatment combination (36 observations).

d. EXPERIMENT 4D: Factors 5, 6 and 7 are each considered active but only two levels of each are utilized, three observations per cell (24 observations).

e. EXPERIMENT 4E: The student calls factor 5 random and 6 and 7 fixed to show that it is the instructor's specification of random/fixed, not the student's which affects the manner in which STEXSIM generates data, 2 observations per cell (54 observations).

f. EXPERIMENT 4F: Same as experiment 4D except one observation per cell (27 observations).

5. MODEL 5: Instructor model 5 tests a two factor random interacting model. Factor 5 is active at 5 levels and factor 7 at 4 levels. Both factors are random.

a. EXPERIMENT 5A: The student matches the instructor's model with one observation per cell (20 observations).

b. EXPERIMENT 5B: Same as experiment 5A but with two observations per cell (40 observations).

c. EXPERIMENT 5C: In this design the student ignores factors 5 and 7 using instead factors 1 (at 5 levels) and 3 (at 4 levels) with two observations per cell (40 observations).

d. EXPERIMENT 5D: The student calls factor 5 fixed and 7 random. He uses 3 levels of factor 5 and 3 of 7 with two observations per cell (18 observations).

e. EXPERIMENT 5E: In this experiment the student ignores factor 7 and uses only 4 levels of factor 5 with 4 observations of each level (20 observations).

6. MODEL 6: A three factor interacting mixed model is tested by specifying factors 5 and 7 as fixed at 3 levels each and factor 6 random, also at 3 levels. Two factor and three factor interactions are all specified.

a. EXPERIMENT 6A: The student's design matches the instructor's model with two observations per cell (54 observations).

b. EXPERIMENT 6B: The student calls all factors random each at three levels with two observations per cell (54 observations).

7. <u>MODEL 7</u>: Model 7 provides a demonstration of the effect of blocking in accounting for sources of variation. Blocking factor 1, 2 and 3 are defined as random while factors 5 and 6 each at 3 levels are fixed and interacting are the factors of interest.

   a. EXPERIMENT 7A: In this experiment the student ignores the blocking factors specifying 8 observations per cell of the factor 5 by factor 6 complete factorial model (72 observations).

   b. EXPERIMENT 7B: Blocking factor 1 is considered at 2 levels with 4 observations per cell (72 observations).

   c. EXPERIMENT 7C: Blocking factors 1 and 2 are each considered (2 levels each) with 2 observations per cell (72 observations).

   c. EXPERIMENT 7D: All three blocking factors, each at two levels are included in the design with one observation per cell (72 observations).

B. STEXSIM RESULTS

Each of the 30 experiments described in the previous section have been executed by the STEXSIM model. The input in Appendix E when run produced the results in Appendix F. In order to conserve space only the student output is shown. For each, however, the instructor output described in Section IIIC was provided. Sufficient input detail is shown in Appendix E to permit one to replicate each of these experiments. It is important to note, however, that because of different random number generators on different computers the specific results would be different as indeed they are with the SUNY/Buffalo computer when a different seed number is used.

The purpose of each of these 30 experiments was to test different conditions under which STEXSIM might be required to function. In each case STEXSIM accomplished specifically what it was designed to accomplish thus demonstrating its ability to cope with the wide range of problems for which it might be required to function.

C. ANALYSIS OF RESULTS

The role of STEXSIM was completed by the generation of the results described in the previous section; i.e. the generation of "data" from the 30 different experiments. However, for the sake of completeness and to demonstrate the full sequence of activities in the use of the simulator, an analysis of variance was run for each of the 30 experiments.

The program used for the analysis was BMDO2V, Analysis of Variance for Factorial Design - developed at the Health Sciences Computing Facility, UCLA. It is documented in reference 2 . The input to BMDO2V for each experiment was the punched card deck provided by STEXSIM. The deck, as is the usual case, had to be sorted into the sequence required by the analysis program. This activity is exactly that which would be followed by an actual student using STEXSIM.

The Analysis of Variance Table for each experiment is included in Appendix G. Hence, even if one did not wish to use the simulator this report provides at least the data for 30 different complete factorial problems with the appropriate analysis which he could use for student problems, text examples, etc.

Careful review of these analyses reveals in several instances results which are counter intuitive, where significance was expected it was not found while where it should not be present it did indeed appear. This should not be considered a weakness of the STEXSIM model and its approach but rather is a reflection of the sensitivity of the model's performance to certain key input parameters. One of the factors surely is the random number generator itself. Many systems simulation studies have witnessed the contributory effect of this generator to the variability of response variables. The others are the various values of treatment and interaction effects and the magnitude of the error variance. In addition the natural variability inherent in any experiment creates unanticipated results at times simply because of the type I and type II statistical error. The magnitude of unanticipated results exceeds that which would normally be expected.

Research is currently under way to examine carefully the effect of various parameters on model response. The basic model used for this study is STEXSIM exactly as described in this report.

Let us consider briefly the results of each analysis.

1. Model 1: The results of experiment 1A are as would be anticipated with both active main effects shown to be statistically significant at the .01 level. The level of significance is surprisingly high however. In experiments 1B and 1C, however, in which the experiment of 1A is replicated twice and three times respectively, the observed error variance

("within replicates") is unusually high causing significance of factor 2 only in experiment 1B and no significance in 1C. 1D produced anticipated results with no significance as the result of the residual variance being inflated by the omission of active factor 2 from the design. Reasonable results were obtained in 1E with the finding of significance for the active factors and not for the extraneous factor 3 which was inactive. A spurious interaction appeared when it should not have been present. 1F produced as anticipated no significance of the two factors included in the design since both were inactive factors.

2. Model 2: Experiment 2A produced reasonable results with both main effects being significant. However in 2B, 2C and 2D in which 2A is replicated 2, 3 and 4 times respectively, surprisingly, no significance was found primarily because of an excessively large error variance estimate. This result is comparable to that of 1B and 1C and is the subject of current investigation. 2E however performed as expected with significance of the only active factor included in the design observed by the contribution to error of the ignored other active factor.

3. Model 3: The two experiments using model 3 gave precisely the predicted results. In 3A the blocking factor is ignored thereby preventing the experimenter from observing the significance of the two active factors of interest. In 3B, on the other hand, the blocking factor is included in the design thereby reducing dramatically the residual variance. Both main effects of interest and their interaction were found to be highly significant.

4. Model 4: In experiment 4A significance was found for each of the three main effects. However, no significance was observed for their two way interactions primarily because the three factor interaction is confounded with the error and hence provides an error estimate that is inflated. In 4B where it had been anticipated that the three factor interaction could be separately tested, the error variance is excessively large so that all tests for significance were negative except factor C which has the greatest effect on the model. The inflated error of 4B is the same phenomenon observed in 1B, 1C, 2B, 2C and 2D in which replication occurred. Experiment 2C gave reasonable results except for a very high level of significance found for factor 1 which in fact was declared to be inactive. 4D yielded disappointing results primarily because of an inflated error term (3 replicates in this experiment). 4E with replication gives inadequate results although 4F without replication provides a significant result for all active factors with the exception of the 5-6-7 interaction which cannot be separated from the error.

5. Model 5: Model 5 gives a test of a two factor random interacting

model. Experiment 5A without replication provided a significant test for factor 5 but not for 6. Since a random model, the fact that the two way interaction is confounded with error is of no significance. Factor 6 while active in the model has only minor effect so that its lack of significance is not surprising. 5B, however, with replication surprisingly failed to show significance for any factor or interaction. In 5C the student ignores the active factors and includes two factors which are inactive. As would be anticipated, no significance was found. 5D with replication showed no significance of any factor. Ignoring one of the active factors in 5E precluded a significance test on the other factor included in the experiment as would be expected.

6. Model 6: In both 6A and 6B which are identical except for that in 6B the student declares all three factors fixed when in fact factor 6 is random, the student finds that the 5-6 interaction is significant in 6A whereas in 6B, although the 5-6 interaction is significant, he fails to detect it because of his improper model. No other factors are found significant.

7. Model 7: Model 7 behaved exactly as predicted. In 7A none of the three blocking factors are included in the design thereby obscuring the test on the two factors of interest (5 and 6). Similarly in 7B with one blocking factor included, the main effects 5 and 6 and their interaction still are not found to be significant. Two blocking factors are included in 7C which provides a significant test on main effects 5 and 6 but not on their interaction. 7D on the other hand yields significance for factors 5, 6 and their interaction as well as significance for the three blocking factors (although their test is not a matter of interest). In proceeding from 7A, 7B, 7C to 7D the residual variance is decreased each time as would be expected. In 7D nearly all the total variance is accounted for.

The results of the analysis of this set of 30 experiments leads to the conclusion that in general the results of the analysis of variance were as anticipated with the major exception that with replication the error variance in nearly all cases unexpectedly increased dramatically thereby obscuring most tests of significance. This phenomenon is currently being investigated. Further, there is an apparent relationship between the predictability of results and the magnitude of the error variance component. These are listed for reference in Table I . The fact that Models 3, 5, 6, and 7 seemed to behave best (except for the replication problem) leads to the tentative conclusion that the smaller the variance the better the results. This is a reasonable conclusion for as the contribution of the error variance approaches or exceeds that of a main effect, the two are likely to become confounded. This phenomenon is also being investigated further.

Table I

Actual Error Standard Deviation

Model	SIGMA
1	0.750
2	1.250
3	0.005
4	0.250
5	0.150
6	0.001
7	0.010

V. CONCLUSIONS AND RECOMMENDATIONS

The Statistical Experiment Simulator (STEXSIM) has been designed, developed and tested. This report has described these aspects of the model in sufficient detail as to permit someone else to utilize the model for his own use.

The model was conceived originally as a teaching device in which the capabilities of the digital computer are exploited to permit the integration of the design and analysis phases of statistical training. It has been structured to permit an instructor to specify a statistical model which then generates "experimental" results for each student according to the student's experimental design. In nearly all ways it is for the student an experience analogous to collecting actual data in a real world experiment with two major benefits not attainable in real world experimentation. First, he can run an experiment quickly and at negligible cost thereby permitting many design experiences. Secondly, his instructor has complete knowledge of the underlying additive model which has generated the student's data. This is invaluable in interpreting results but is never available in real world experimentation.

While highly successful in accomplishing this original design goal, a number of other secondary benefits have become evident as the model development has evolved. Foremost among these is the role of STEXSIM as a demonstration device. An instructor in a course in experimental design could use the model to demonstrate certain concepts he might be covering without the student actually having to submit a design of his own. Experiment 7 is a good example of how an instructor might demonstrate the role of blocking in improving the power of a design. Beyond its demonstration role STEXSIM is already establishing a place as a research tool and as a generator of standard "text book" problems.

To test the STEXSIM model seven "instructor" models have been formulated each of which has been used to generate data for from two to six "student" experimental designs. In total 30 different experiments have been run and analyzed in order to test as many aspects of STEXSIM as possible. These have each been described in previous sections. Each of these experiments were complete factorial designs with equal cell sizes. This was done so as to utilize a particular analysis routine. However, there is nothing inherent in STEXSIM which requires the use of a completely balanced design. STEXSIM generates an "observation" for a single specification of various treatment combinations to be controlled for that observation. Therefore the flexibility of STEXSIM permits any experiment which has an underlying factorial model. It can be used for fractional designs, Latin Squares, Graeco-Latin Squares, etc. Furthermore it can aid in the study of the handling of unequal cell sizes or missing observations.

The analysis of these 30 experiments pointed out certain

problems in the selection of parameter values to be used in the model. These center primarily on the relationship of the magnitude of the error variance to the magnitude of incremental treatment effects. Difficulties were particularly evident in replicated designs in which treatment effects are becoming confounded with the error term. The problem quite clearly is with parameter selection and not with the STEXSIM model. Accordingly, research is currently underway on parameter selection.

Further research is recommended and is currently planned to extend the STEXSIM model to handle unequal variances, non-normality and other designs for which a different model structure is needed as nested designs for example. In addition it is planned to add a time dependent factor which will contribute an effect to an observation proportional to place of that observation in the sequence of samples in an experiment. This will permit the explicit inclusion of the effect of randomization. If a student failed to randomize, this time dependent effect (with proper parameter values) will be confounded with a possible main effect perhaps giving a false indication of significance of that main effect. With randomization the time factor can be confounded with the error. With blocking and randomization he should be able to remove it from error and main effect thereby providing a correct test for significance.

The concept of STEXSIM is supportive of the manner in which experimental statistics is taught in an applied discipline (as engineering, psychology, education, for example). In these areas a student generally gains understanding of concepts primarily through experience, both personal and vicariously through demonstration. He also learns appropriate theory but yet there remains the philosophy of learning by doing. This is contrasted to the learning of statistics from a theoretical point of view in which understanding of concepts arises through mathematical processes rather than experience. Both forms of teaching are appropriate but it should be recognized that they each utilize different methodologies for different audiences. STEXSIM's role is clearly in the area of applied statistics.

The term Computer Aided Instruction (CAI) has evolved primarily in the area of programmed instruction. It is believed that the approach of STEXSIM is a new and powerful form of CAI and one which should be exploited.

VI. REFERENCES

1. Box, G.E.P. and Muller, M. E. "A Note on the Generation of Normal Deviates," Annals of Mathematical Statistics, XXIX (1958), 610-611.

2. Dixon, W. J. (ed.) BMD, Biomedical Computer Programs, Health Sciences Computing Facility, School of Medicine, University of California, Los Angeles (Rev 1965).

3. Johnson, N. L. and Leone, F. C. Statistics and Experimental Design: In Engineering and the Physical Sciences. Vol. 2. John Wiley and Sons, 1964.

4. Mize, J. H. PROSIM V Administrator's Manual: Production System Simulator, Prentice-Hall, 1971.

5. Mize, J. H. Production System Simulator (PROSIM V): A User's Manual, Prentice-Hall, 1971.

6. Naylor, T. H., Balintfy, J. L., Burdick, D. S., Chu, K. Computer Simulation Techniques, John Wiley and Sons, 1966.

7. Porter, J. C., Sasieni, M. W., Marks, E. S. and Ackoff, R. L. "The Use of Simulation as a Pedagogical Device," Management Science, Vol. 12, No. 6, Feb. 1966, 170-179.

APPENDIX A

GLOSSARY OF VARIABLE DEFINITIONS

VARIABLE DEFINITION

1. First defined in instructor input section of MONITOR

IACT(I)	=	1 if factor I is active in model 2 if factor I is inactive
IFLAG(I)	=	1 if factor I is fixed in model 2 if factor I is random or not used
LI(I)	=	number of active levels of factor I
FMU	=	overall mean
NSTUD	=	number of students for whom input designs (Set B) are provided
AI(I,J)	=	additive incremental effect of Jth level of factor I
BI(IC,L3,L4):		matrix of incremental 2 way interaction effects of interaction IC where IC = 1 for interaction 5-6 2 " " 5-7 3 " " 6-7 L3 = levels of first factor L4 = " " second factor
CI(L1,L2,L3):		matrix of incremental 3 way (5-6-7) interaction effects L1 = level of factor 5 L2 = level of factor 6 L3 = level of factor 7
IN(K)	=	1 if interaction K is active and has a random component 0 if interaction K is inactive or if active is fixed where K = 8 refers to 5-6 interaction = 9 " " 5-7 " = 10 " " 6-7 " = 11 " " 5-6-7 "
NST	=	identification of student currently being processed

FLIM(I,1)	=	lower limit on random effect for factor I
FLIM(I,2)	=	upper " " " " " " "
STD(I)	=	standard deviation of random effects component for factor I (effect selected from N(0,STD(I)^2)

where I = 1,...,7 for main effects I
= 8 for 5-6 interaction
= 9 " 5-7 "
= 10 " 6-7 "
= 11 " 5-6-7 "

SIGMA	=	standard deviation of error component (error selected from N(0,SIGMA^2)
NSEED	=	random number generator seed
PUNSW	=	contents of first three columns of punch control card (PUN for punching, anything else for no punching)

2. First defined in student input section of MONITOR

NAME		stores alphanumeric contents of student's identification card
INCLD(I)	=	1 if factor I is deemed active by student 2 " " " " " not active by student
KEY(I)	=	1 if factor I is assumed fixed by student 2 " " " " " random " "
NRUN	=	number of observations requested by student
LS(I)	=	number of different levels of factor I used by student
LEV(I,L)	=	identification of Lth level of factor I (L ≤ LS(I))
IW1(L,I)	=	level of factor I included in observation request L
	=	0 if factor is not deemed active by student
IW(L,I)	=	level of factor I used to generate observation L (includes model generated levels when student fails to use all active factors in addition to IW1(I,J)
	=	0 if factor is not active nor deemed active by student

IA(I)		1 if factor I is fixed active factor used by student 2 if factor I is fixed active factor not used by student 3 if factor I is random active factor used by student 4 if factor I is random active factor not used by student 5 if factor I is not an active factor
ISW:		a printing control switch 0 if student does not ignore any active factor 1 if student has ignored any active factor
YD(L)	=	Lth observation of dependent variable

3. First defined in TRADJ

FMSS:		adjusted mean equal to FMU compensated for student not requesting all levels of each fixed factor
AS(I,J):		similar to AI(I,J) except adjusted for any levels of fixed factor I which are not included in student's design
BS(IC,L3,L4):		similar to BI(IC,L3,L4) except adjusted for any levels of fixed two interacting factors not included in student's design
CS(L1,L2,L3):		similar to CI(L1,L2,L3) except adjusted for any levels of fixed three interacting factors not included in student's design
IOUT	=	1 if no errors encountered 2 if LS(I) > LI(I) for any fixed main effect I (to abort execution of student's model)
ADELTA(I)	:	adjustment needed for each level of main effect I
BDELTA(IJ)	=	adjustment needed for each cell of following two factor interactions IJ = 1 5-6 = 2 5-7 = 3 6-7
CDELTA	=	adjustment needed for each treatment combination of 5-6-7 three way interaction

4. First defined in subroutine AMEAN

FMS = observation of dependent variable before error has been added

All other variables are defined and used locally within the various subroutines.

APPENDIX B

STEXSIM PROGRAM LISTING

```
      PROGRAM MONITOP (INPUT,OUTPUT,PUNCH,TAPE7=PUNCH,TAPE5=INPUT)
      COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLT(7),
     1KEY(7) ,LEV(7,10) ,LS(7) ,IW1(200,7),IA(7 ) ,IW(200,7),NAME(80)
      COMMON/REEL/ AI(7,10) ,BI(3,10,10) ,CI(10,10,10) ,AS(7,10),
     1BS(3,10,10) ,CS(10,10,10) ,FLIM(11,2),STC(11),ADELTA(7),
     2BDELTA(3) ,CDELTA ,OUT(10,10) ,Y(100),YD(200),PUNSW,SIGMA
C     INSTRUCTOR INPUT DATA SECTION: STATEMENTS 101-117
C     READ SWITCH TO CONTROL PUNCHING
      READ 105,PUNSW
  105 FORMAT(A3)
 9999 CONTINUE
      ISW=0
C     READ IACT,IFLAG,LI TABLES AND GENERAL MEAN
      READ 101,(IACT(J),J=1,7),(IFLAG(J),J=1,7),(LI(J),J=1,7),FMU,NSTUD
  101 FORMAT (7I1,7I1,7I2,F10.4,I2)
      IF(EOF,5)550,551
  550 CALL EXIT
  551 CONTINUE
C     READ AI,BI,CI TABLES
      DO 400 I=1,7
      DO 400 J=1,10
  400 AI(I,J)=0.0
      DO 401 I=1,10
      DO 401 J=1,10
      DO 401 K=1,3
  401 BI(K,I,J)=0.0
      DO 402 I=1,10
      DO 402 J=1,10
      DO 402 K=1,10
  402 CI(I,J,K)=0.0
C     FIRST READ AI TABLE,I.E.,MAIN EFFECTS
      DO 102 L=1,7
      L1=IACT(L)
      GO TO (103,102),L1
  103 K=IFLAG(L)
      GO TO (213,102),K
  213 M=LI(L)
      READ 104,(AI(L,J),J=1,M)
  104 FORMAT (10F8.4)
  102 CONTINUE
      PRINT 100,(IACT(J),J=1,7),(IFLAG(J),J=1,7),(LI(J),J=1,7),FMU,NSTUD
  100 FORMAT (1H1,7I1,7I1,7I2,F10.4,I2)
C     READ BI TABLE, I.E., TWO WAY INTERACTIONS
      DO 110 L1=5,6
      N=L1+1
      DO 110 L2=N,7
      IS=IACT(L1)*IACT(L2)
      PRINT 99, L1,L2,IACT(L1),IACT(L2),IS
   99 FORMAT(5I5)
      IF(IS-2)111,110,110
  111 IF(IFLAG(L1).NE.1.OR.IFLAG(L2).NE.1) GO TO 110
      IF(L1*L2-35)106,107,108
  106 IC=1
      GO TO 109
```

```
  107 IC=2
      GO TO 109
  108 IC=3
  109 M1=LI(L1)
      M2=LI(L2)
      DO 121 L3=1,M1
      PRINT 98, L1,L2,IACT(L1),IACT(L2),IS,M1,M2
   98 FORMAT(7I8)
      READ 104,(BI(IC,L3,L4),L4=1,M2)
  121 CONTINUE
  110 CONTINUE
C     READ CI TABLE,I.E., THREE WAY INTERACTION
      IF(IACT(5)*IACT(6)*IACT(7)-2)112,114,114
  112 IF(IFLAG(5)*IFLAG(6)*IFLAG(7).NE.1) GO TO 114
      N1=LI(5)
      N2=LI(6)
      N3=LI(7)
      DO 113 L1=1,N1
      DO 113 L2=1,N2
      READ 104,(CI(L1,L2,L3),L3=1,N3)
  113 CONTINUE
C     READ RANDOM EFFECTS FACTOR DATA
  114 DO 117 J=1,7
      K=IACT(J)
      GO TO (116,117),K
  116 K=IFLAG(J)
      GO TO (117,115),K
  115 READ 104,(FLIM(J,K),K=1,2),STD(J)
  117 CONTINUE
      DO 315 K=8,11
  315 IN(K)=0
C     READ TWO WAY INTERACTION IF EITHER FACTOR IS RANDOM
      DO 310 L1=5,6
      N=L1+1
      DO 310 L2=N,7
      IF(IACT(L1)*IACT(L2).NE.1) GO TO 310
      IF(IFLAG(L1).EQ.1.AND.IFLAG(L2).EQ.1) GO TO 310
      IF(L1*L2-35) 306,307,308
  306 IC=8
      GO TO 309
  307 IC=9
      GO TO 309
  308 IC=10
  309 IN(IC)=1
      READ 104,(FLIM(IC,K),K=1,2),STD(IC)
  310 CONTINUE
C     READ THREE WAY VARIANCE COMPONENT
      IF(IACT(5)*IACT(6)*IACT(7)-2) 312,314,314
  312 IF(IFLAG(5)*IFLAG(6)*IFLAG(7).EQ.1) GO TO 314
      READ 104,(FLIM(11 ,K),K=1,2),STD(11)
      IN(11)=1
  314 CONTINUE
      READ 120,SIGMA,NSEED
  120 FORMAT (F8.4,I8)

C     STUDENT DATA INPUT SECTION

      DO 999 NST=1,NSTUD
      READ 210,(NAME(I),I=1,80)
  210 FORMAT (80A1)
      READ 201,(INCLD(J),J=1,7),(KEY(J),J=1,7),NRUN
```

```
  201 FORMAT (7I1,7I1,I5)
C     INPUT NUMBER LEVELS AND ACTUAL LEVELS FOR FACTORS USED
      DO 202 K=1,7
      IS=INCLD(K)
      GO TO (204,202),IS
  204 READ 203,M,(LEV(K,J),J=1,M)
      LS(K)=M
  203 FORMAT (I2,10I2)
  202 CONTINUE
C     INPUT SET OF EXPER. COND. FOR OBSERVATIONS
      READ 205,((IW1(I,J),J=1,7),I=1,NRUN)
  205 FORMAT ( 7I2)
      DO 123 I=1,NRUN
      DO 123 J=1,7
      IF (IW1(I,J).EQ.0)IW1(I,J)=0
  123 CONTINUE
C     CONSTRUCT IA(J) TABLE FROM STUDENT DATA
      DO 1 J=1,7
      L=IACT(J)
      GO TO (2,3),L
    3 IA(J)=5
      GO TO 1
    2 L=IFLAG(J)
      GO TO (4,5),L
    4 IA(J)=INCLD(J)
      GO TO 1
    5 IA(J)=2+INCLD(J)
    1 CONTINUE
C     GENERATE OMITTED DATA, CONSTRUCT AS,BS,CS TABLES
       DO 20 M1 = 1,200
       DO 20 M2 = 1,7
      IW(M1,M2) = 0
   20 CONTINUE
      DO 10 J=1,7
      K1=IA(J)
      DO 15 I=1,NRUN
   15 IW(I,J)=IW1(I,J)
      GO TO (6,7,8,9,10),K1
C     FIXED, ACTIVE FACTOR USED BY STUDENT
    6 GO TO 10
C     FIXED, ACTIVE FACTOR, NOT USED BY STUDENT
    7 CALL LEVSEL(J,NRUN)
      ISW=1
      GO TO 10
C     RANDOM, ACTIVE FACTOR USED BY STUDENT
C     GENERATE TREATMENT EFFECTS FOR FACTOR J
    8 CALL RTRT(J)
      GO TO 10
C     RANDOM, ACTIVE FACTOR NOT USED BY STUDENT
    9 CALL LEVSEL(J,NRUN)
      ISW=1
      CALL RTRT(J)
      GO TO 10
   10 CONTINUE
C     GENERATE EFFECTS FOR INTERACTIONS IF RANDOM OR MIXED MODEL
      DO 510 K=8,11
      IF (IN(K).NE.1) GO TO 510
      CALL RINTER(K)
  510 CONTINUE
```

```
      CALL TRADJ(IOUT,FMU,FMSS)
      GO TO (118,999),IOUT
C     COMPUTE EMPERICAL DATA FOR EXPERIMENT
  118 DO 11 L=1,NRUN
      CALL AMEAN(L,FMU,FMS)
      YD(L)=FMS+FNORM(SIGMA,NSEED)
   11 CONTINUE
       CALL OUTPUT ( NST,NRUN,FMU,FMSS)
  999 CONTINUE
      GO TO 9999
      END


      SUBROUTINE TRADJ(IOUT,FMU,FMSS)

       COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLD(7),
     1KEY(7).,LEV(7,10) ,LS(7) ,IW1(200,7),IA(7 ) ,IW(200,7),NAME(80)
       COMMON/REEL/ AI(7,10) ,BI(3,10,10) ,CI(10,10,10) ,AS(7,10),
     1BS(3,10,10) ,CS(10,10,10) ,FLIM(11,2),STD(11),ADELTA(7),
     2BDELTA(3) ,CDELTA ,CLT(10,10) ,Y(100),YD(200),PUNSW,SIGMA

      DO 100 I=1,7
      DO 100 J=1,10
  100 AS(I,J)=0.0
      DO 101 I=1,10
      DO 101 J=1,10
      DO 101 K=1,3
  101 BS(K,I,J)=0.0
      DO 102 I=1,10
      DO 102 J=1,10
      DO 102 K=1,10
  102 CS(I,J,K)=0.0
C     ADJUST MAIN EFFECT TREATMENTS

       FMSS=FMU
      IOUT=1
      DO1 I=1,7
      IF(IACT(I)*IFLAG(I)-2) 2,1,1
    2 IF(LI(I)-LS(I)) 3,4,5
    3 PRINT8,I
      IOUT=2
    8 FORMAT(*  FACTOR  *,I2,* NO. LEVELS USED IS TOO HIGH*)
      GO TO 1
    4 ADELTA(I)=0.0
      N=LI(I)
      DO 7 K=1,N
      AS(I,K)=AI(I,K)
    7 CONTINUE
      GO TO 1
    5 N=LS(I)
      FN=N
      SUM=0.0
      DO6 K=1,N
      K1=LEV(I,K)
      SUM=SUM+AI(I,K1)
    6 CONTINUE
      ADELTA(I)=SUM/FN
```

```
       FMSS= FMSS + ADELTA(I)
      DO 9 K=1,N
      K1=LEV(I,K)
      AS(I,K)=AI(I,K1)-ADELTA(I)
    9 CONTINUE
    1 CONTINUE
      GO TO (20,62),IOUT
C     ADJUST 2-WAY INTERACTION TERMS
   20 DO 21 I1=5,6
      II=I1+1
      DO 21 I2=II,7
      IF(I1*I2-35) 33,34,35
   33 IJ=1
      GO TO 22
   34 IJ=2
      GO TO 22
   35 IJ=3
   22 IF(IACT(I1)*IACT(I2)*IFLAG(I1)*IFLAG(I2)-2) 23,21,21
   23 I3=LI(I1)-LS(I1)
      IF(I3) 24,25,25
   25 N1=LS(I1)
   26 IF(LI(I2)-LS(I2)) 27,28,29
   27 PRINT8,I2
      IOUT=2
      GO TO 21
   24 PRINT8,I1
      IOUT=2
      GO TO 26
   28 IF(I3) 21,36,29
   36 N2=LS(I2)
      DO 30 K1=1,N1
      DO 30 K2=1,N2
      BDELTA(IJ)=0.0
      BS(IJ,K1,K2)=BI(IJ,K1,K2)
   30 CONTINUE
      GO TO 21
   29 N2=LS(I2)
      SUM=0.0
      FN=N1*N2
      DO 31 K1=1,N1
      DO 31 K2=1,N2
      K3=LEV(I1,K1)
      K4=LEV(I2,K2)
      SUM=SUM+BI(IJ,K3,K4)
   31 CONTINUE
      BDELTA(IJ)=SUM/FN
       FMSS = FMSS + BDELTA(IJ)
      DO 32 K1=1,N1
      DO 32 K2=1,N2
      K3=LEV(I1,K1)
      K4=LEV(I2,K2)
      BS(IJ,K1,K2)=BI(IJ,K3,K4)-BDELTA(IJ)
   32 CONTINUE
   21 CONTINUE
      GO TO (40,62),IOUT
C     ADJUST 3-WAY INTERACTIONS
   40 [illegible]
```

```
      I2=6
      I3=7
      IC=IACT(I1)*IACT(I2)*IACT(I3)
      IB=IFLAG(I1)*IFLAG(I2)*IFLAG(I3)
      IF(IC*IB-2) 41,62,62
   41 IF(LI(I1)-LS(I1)) 42,43,44
   42 PRINT 8,I1
      IOUT=2
      GO TO 62
   43 IADJ=1
      GO TO 45
   44 IADJ=2
      GO TO 45
   45 IF (LI(I2)-LS(I2)) 46,48,47
   46 PRINT 8,I2
      IOUT=2
      GO TO 62
   47 IADJ=2
      GO TO 48
   48 IF(LI(I3)-LS(I3))49,51,50
   49 PRINT 8,I3
      IOUT=2
      GO TO 62
   50 IADJ=2
   51 N1=LS(I1)
      N2=LS(I2)
      N3=LS(I3)
      GO TO (52,53),IADJ
   52 CDELTA=0.0
      DO 54 I=1,N1
      DO 54 J=1,N2
      DO 54 K=1,N3
      CS(I,J,K)=CI(I,J,K)
   54 CONTINUE
      GO TO 62
   53 FN=N1*N2*N3
      SUM=0.0
      DO 55 K1=1,N1
      DO 55 K2=1,N2
      [illegible]
      K4=LEV(I1,K1)
      K5=LEV(I2,K2)
      K6=LEV(I3,K3)
      SUM=SUM+CI(K4,K5,K6)
   55 CONTINUE
      CDELTA=SUM/FN
       FMSS = FMSS + CDELTA
      DO 56 K1=1,N1
      DO 56 K2=1,N2
      DO 56 K3=1,N3
      K4=LEV(I1,K1)
      K5=LEV(I2,K2)
      K6=LEV(I3,K3)
      CS(K1,K2,K3)=CI(K4,K5,K6)-CDELTA
   56 CONTINUE
   62 RETURN
      END

      SUBROUTINE LEVSEL (J,NRUN)
```

```
      COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLD(7),
     1KEY(7) ,LEV(7,10) ,LS(7) ,IW1(200,7),IA(7 ) ,IW(200,7),NAME(80)
      DIMENSION ISEL(10),FR(10)
      DATA LSEED/9399/
C   CLEAR USE COUNTER
      DO 1 K=1,10
    1 ISEL(K)=1
C   FORM CUMULATIVE DISTRIBUTION
      KLIM=LI(J)
      FACT=1.0/FLOAT(KLIM)
      DO 2 K=1,KLIM
    2 FR(K)=FACT*FLOAT(K)
      DO 3 L=1,NRUN
C   MAKE SELECTION
      XR=RND(LSEED)
      DO 10 LEVEL=1,10
      IF(XR.LE.FR(LEVEL)) GO TO 20
   10 CONTINUE
      PRINT 100
  100 FORMAT (1X,*FAILURE TO MAKE SELECTION IN LEVSEL*)
      LEVEL = 10
   20 IW(L,J) = LEVEL
    3 ISEL(LEVEL)=2
      NLEV=0
      DO 30 K=1,10
      I1=ISEL(K)
      GO TO (30,31),I1
   31 NLEV=NLEV+1
      LEV(J,NLEV)=K
   30 CONTINUE
      LS(J)=NLEV
      RETURN
      END



      SUBROUTINE PTRT(J)

      COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLD(7),
     1KEY(7) ,LEV(7,10) ,LS(7) ,IW1(100,7),IA(7 ) ,IW(200,7)
      COMMON/REEL/ AI(7,10) ,B1(3,10,10) ,CI(10,10,10) ,AS(7,10),
     1BS(3,10,10) ,CS(10,10,10) ,FLIM(11,2),STD(11),ADELTA(7),
     2BDELTA(3) ,CDELTA ,OUT(10,10) ,Y(100),YD(200),FUNSW,SIGMA

      DATA LSEED/1111/
      K=LI(J)
      ST=STD(J)
      LOW=FLIM(J,1)
      HIGH=FLIM(J,2)
      DO 1 L=1,K
      DO 2 II=1,1000
      EF = FNORM (ST,LSEED)
      IF(EF.LT.LOW.OR.EF.GT.HIGH)GO TO 2
      GO TO 11
    2 CONTINUE
      PRINT 101,J
  101 FORMAT(*  FAILURE TO SELECT RANDOM FACTOR IN  PTRT FOR J=*,I5)
      RETURN
   11 AI(J,L)=EF
    1 CONTINUE
```

```
      RETURN
      END

      SUBROUTINE RINTER(K)

      COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLD(7),
     1KEY(7) ,LEV(7,10) ,LS(7) ,IW1(200,7),IA(7 ) ,IW(200,7),NAME(80)
      COMMON/REEL/ AI( ,10) ,BI(3,10,10) ,CI(10,10,10) ,AS(7,10),
     1PS(3,10,10) ,CS(10,10,10) ,FLIM(11,2),STD(11),ADELTA(7),
     2BDELTA(3) ,CDELTA ,CUT(10,10) ,Y(100),YD(200),PUNSW,SIGMA

      DATA LSEED/77117/

      LOW=FLIM(K,1)
      HIGH = FLIM(K,2)
      ST=STD(K)
      GO TO (1,1,1,1,1,1,1,8,9,10,11),K
    1 RETURN
    8 M1=5
      M2=6
      IC=1
      GO TO 80
    9 M1=5
      M2=7
      IC=2
      GO TO 80
   10 M1=6
      M2=7
      IC=3
   80 L1=LI(M1)
      L2=LI(M2)
      DO 81 I=1,L1
      DO 81 J=1,L2
      DO 82 II=1,1000
      EF=FNORM(ST,LSEED)
      IF(EF.LT.LOW.OR.EF.GT.HIGH)GO TO 82
      GO TO 95
   82 CONTINUE
      PRINT 101,K
  101 FORMAT (*  FAILURE TO SELECT RANDOM FACTOR IN RINTER FOR K=*,I5)
      RETURN
   95 BI(IC,I,J)=EF
   81 CONTINUE
      RETURN
   11 L1=LI(5)
      L2=LI(6)
      L3=LI(7)
      DO 90 I=1,L1
      DO 90 J=1,L2
      DO 90 KKK=1,L3
      DO 92 II=1,100
      EF=FNORM(ST,LSEED)
      IF(EF.LT.LOW.OR.EF.GT.HIGH)GO TO 92
      GO TO 93
   92 CONTINUE
      PRINT 101,K
      RETURN
   93 CI(I,J,KKK)=EF
   90 CONTINUE
```

```
      RETURN
      END


      SUBROUTINE AMEAN(L,FML,FMS)

      COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLD(7),
     1KEY(7) ,LEV(7,10) ,LS(7) ,IH1(200,7),IA(7 ) ,IW(200,7),NAME(80)
      COMMON/REEL/ AI(7,10) ,BI(3,10,10) ,CI(10,10,10) ,AS(7,10),
     1BS(3,10,10) ,CS(10,10,10) ,FLIM(11,2),STD(11),ADELTA(7),
     2BDELTA(3) ,CDELTA ,CUT(10,10) ,Y(100),YC(200),PUNSW,SIGMA

C     CHANGES IN MEAN DUE TO MAIN EFFECTS

      FMS=FMU
      DO 1 I=1,7
      LL=IACT(I)
      GO TO (2,1),LL
    2 II= IW(L,I)
      FMS=FMS+AI(I,II)
    1 CONTINUE

C     CHANGES IN MEAN DUE TO 1ST ORDER INTERACTIONS

      DO 3 I=5,6
      I1=I+1
      DO 3 J=I1,7
      IF(I*J-35)4,5,6
    4 IJ=1
      GO TO 7
    5 IJ=2
      GO TO 7
    6 IJ=3
    7 IF (IACT(I)*IACT(J)-2)8,3,3
    8 L1=IW(L,I)
      L2=IW(L,J)
      FMS=FMS+BI(IJ,L1,L2)
    3 CONTINUE

C     CHANGES IN MEAN DUE TO 2ND ORDER INTERACTIONS

      IF (IACT(5)*IACT(6)*IACT(7)-2) 9,10,10
    9 L1=IW(L,5)
      L2=IW(L,6)
      L3=IW(L,7)
      FMS=FMS+CI(L1,L2,L3)
   10 RETURN
      END


       SUBROUTINE OUTPUT(NST,NFLN,FML,FMSS)

      COMMON/INTGR/ IACT(7) ,IFLAG(7) ,LI(7) ,ISW,IN(11),INCLD(7),
     1KEY(7) ,LEV(7,10) ,LS(7) ,IH1(200,7),IA(7 ) ,IW(200,7),NAME(80)
      COMMON/REEL/ AI(7,10) ,BI(3,10,10) ,CI(10,10,10) ,AS(7,10),
     1BS(3,10,10) ,CS(10,10,10) ,FLIM(11,2),STD(11),ADELTA(7),
     2BDELTA(3) ,CDELTA ,CUT(10,10) ,Y(100),YC(200),PUNSW,SIGMA
      DIMENSION ICODE(84)
      DATA IASK/1H*/,IBLANK/1H /,IPLUS/1H+/,PUN/3HPUN/
```

```
C       PUNCH SEGMENT FOR GENERATED DATA
        IF (PUNSW.NE.PUN) GO TO 999
        DO 71 J=1,80
     71 ICODE(J)=IPLUS
        PUNCH 72,(ICODE(J),J=1,80)
     72 FORMAT (80A1)
        PUNCH 72,(NAME(I),I=1,80)
        PUNCH 73,NST
     73 FORMAT (I10)
        PUNCH 70,(YD(L),(IW1(L,J),J=1,7),L=1,NRUN)
     70 FORMAT ( (F10.4,7I4))
    999 CONTINUE
C       OUTPUT SEGMENT FOR GENERATED DATA; TWO COPIES
C       PRINT RUN IDENTIFIER SECTION
        DO 81 IB=1,80
        IF (NAME(IB).NE.IBLANK) GO TO 82
     81 CONTINUE
        IB=1
     82 DO 83 I=1,80
        IE=81-I
        IF (NAME(IE).NE.IBLANK) GO TO 84
     83 CONTINUE
        IE=80
     84 IE=IE+4
C       PROVIDE TWO COPIES
        DO 64 K=1,2
        PRINT 101
    101 FORMAT (1H1)
        DO 80 I=1,84
     80 ICODE(I)=IBLANK
        DO 86 I=IB,IE
     86 ICODE(I)=IASK
        PRINT 103,(ICODE(I),I=1,84)
    103 FORMAT(31X,84A1)
        DO 87 I=1,84
     87 ICODE(I)=IBLANK
        ICODE(IB)=IASK
        ICODE(IE)=IASK
        PRINT 103,(ICODE(I),I=1,84)
        DO 88 I=1,80
     88 ICODE(I+2)=NAME(I)
        ICODE(IB)=IASK
        ICODE(IE)=IASK
        PRINT 63,NST,(ICODE(I),I=1,84)
     63 FORMAT (1H ,5X,*STUDENT NUMBER*,I5,6X,84A1)
        DO 89 I=1,84
     89 ICODE(I)=IBLANK
        ICODE(IB)=IASK
        ICODE(IE)=IASK
        PRINT 103,(ICODE(I),I=1,84)
        DO 90 I=IB,IE
     90 ICODE(I)=IASK
        PRINT 103,(ICODE(I),I=1,84)
        PRINT 102
    102 FORMAT(///)
        PRINT 60
     60 FORMAT (+5X,*FACTOR LEVELS*,/12X,*OBSERVATION     1          2
```

```
     1   3        4         5         6         7*,//)
      DO 61 L=1,NRUN
      PRINT 62, L,YD(L),(IW1(L,J),J=1,7)
   62 FORMAT (6X,I4,F10.4,7(I8,2X))
   61 CONTINUE
      IF(PUNSW.NE.PUN) GO TO 302
      PRINT 300
  300 FORMAT (1H0,*PUNCHED OUTPUT SPECIFIED*)
      GO TO 64
  302 PRINT 301
  301 FORMAT (1H0,*NO PUNCHED OUTPUT*)
   64 CONTINUE
C     PRINT FACTORS USED INCLUDING THOSE GENERATED BY MODEL
      IF(ISW.EQ.0) GO TO 67
   65 FORMAT (1H0,5X,*FACTORS USED BY MODEL IF DIFFERENT*)
      PRINT 65
      PRINT 60
      DO 66 L=1,NRUN
   66 PRINT 62,L,YD(L),(IW(L,J),J=1,7)
      ISW=0
C     PRINT INSTRUCTOR DATA; FACTORS INVOLVED
   67 PRINT 530
  530 FORMAT (//,5X,*INSTRUCTOR INPUT , FACTORS INVOLVED*,//)
      PRINT 531
  531 FORMAT (5X,*  FACTOR    ACTIVE     TYPE     NO. LEVELS  *,/ )
      DO 20 J=1,7
      I=IACT(J)
      GO TO (21,22),I
   21 I=IFLAG(J)
      GO TO (23,24),I
   23 PRINT 532,J,LI(J)
  532 FORMAT (10X,I1,4X,*     YES       FIXED  *,6X,I2)
      GO TO 20
   24 PRINT 533,J,LI(J)
  533 FORMAT (10X,I1,4X,*     YES       RANDOM *,6X,I2)
      GO TO 20
   22 PRINT 534,J
  534 FORMAT (10X,I1,4X,*     NO*)
      GO TO 20
   20 CONTINUE
C     PRINT STUDENT DATA, FACTORS USED
      PRINT 535
  535 FORMAT ( //,5X,*STUDENT INPUT , FACTORS USED*,//)
      PRINT 536
  536 FORMAT (5X,*  FACTOR     USED      TYPE     NO. LEVELS
     1LEVELS USED*,/)
      DO 25 J=1,7
      I=INCLD(J)
      GO TO (26,27),I
   26 I=KEY(J)
      GO TO (28,29),I
   28 M=LS(J)
      PRINT 537,J,LS(J),(LSV(J,K),K=1,M)
  537 FORMAT (10X,I1,4X,*     YES       FIXED  *,6X,I2,6X,10I5)
      GO TO 25
```

```
   29 M=LS(J)
      PRINT 538,J,LS(J),(LEV(J,K),K=1,M)
  538 FORMAT (10X,I1,4X,*     YES       RANDOM *,6X,I2,6X,10I5)
      GO TO 25
   27 PRINT 539 ,J
  539 FORMAT (10X,I1,4X,*     NO*)
      GO TO 25
   25 CONTINUE
   30 PRINT 540,FMU,FMSS
  540 FORMAT (//,5X,*OVERALL AVERAGE*,//,10X,*INSTRUCTOR VALUE*,F10.2,
     1/,10X,*STUDENT VALUE    *,F10.2,//)

C     PRINT INSTRUCTOR INPUT, *AI* MAIN EFFECTS

      PRINT 550
  550 FORMAT (5X,*INSTRUCTOR INPUT*,/,5X,*BLOCKING AND MAIN EFFECTS*,//)
      PRINT 551
  551 FORMAT (5X,*  FACTOR    NO. LEVELS    TRT. EFFECTS*,//)
      DO 40 I=1,7
      K=IACT(I)
      GO TO (41,40),K
   41 M1=LI(I)
      PRINT 552,I,M1,(AI(I,J),J=1,M1)
  552 FORMAT (10X,I1,10X,I2,8X,10F8.3)
   40 CONTINUE

C     PRINT INSTRUCTOR INPUT, *BI* TWO-WAY INTERACTIONS

      PRINT 553
  553 FORMAT(//5X,*INSTRUCTOR INPUT*/5X,*TWO WAY INTERACTION EFFECTS*)
      DO 42 I1=5,6
      II=I1+1
      DO 42 I2=II,7
      IF(IACT(I1)*IACT(I2)-2)48,42,42
   48 IF(I1*I2-35)43,44,45
   43 IJ=1
      GO TO 46
   44 IJ=2
      GO TO 46
   45 IJ=3
   46 M1=LI(I1)
      M2=LI(I2)
      PRINT 554,I1,I2
  554 FORMAT(1H0,*ROWS-FACTOR*,I5,/,5X,*COLUMNS-FACTOR*,I5,//)
      PRINT 555
  555 FORMAT (5X,*  ROW       TRT. EFFECTS*,//)
      DO 47 I=1,M1
      PRINT 556,I,(BI(IJ,I,J),J=1,M2)
  556 FORMAT (3X,I1,5X,10F8.3)
   47 CONTINUE
   42 CONTINUE

C     PRINT INSTRUCTOR INPUT, *CI* THREE-WAY INTERACTION

      PRINT 557
  557 FORMAT (//,5X,*INSTRUCTOR INPUT*,/,5X,*3-WAY INTERACTION EFFECTS*)
      IF(IACT(5)*IACT(6)*IACT(7)-2)50,53,53
   50 M1=LI(5)
      M2=LI(6)
      M3=LI(7)
      DO 52 I=1,M1
```

```
      PRINT 558,I
  558 FORMAT(1H0,*LEVEL OF FACTOR 5 IS*,I5,//)
      PRINT 559
  559 FORMAT (5X,* FACTOR 6   NO. LEVELS     TRT. EFFECTS*,/,
     15X,        *   LEVEL       FACTOR 7*,//)
      DO 52 J=1,M2
      PRINT 560,J,M3,(CI(I,J,K),K=1,M3)
  560 FORMAT (9X,I1,10X,I1,10X,10F8.3)
   52 CONTINUE
   53 CONTINUE
      PRINT 561,SIGMA
  561 FORMAT (1H0,5X,*SIGMA = *,F10.5)

C     OUTPUT MAIN EFFECTS:*AS* TABLE

      DO 19 I=1,10
      DO 19 J=1,10
      OUT(I,J)=0.0
   19 CONTINUE
      DO 1 I=1,7
      K=IACT(I)
      GO TO (2,1),K
    2 M1=LS(I)
      DO 1 J=1,M1
      K1=LEV(I,J)
      OUT(I,K1)=AS(I,J)
    1 CONTINUE
      PRINT 501
  501 FORMAT(1H05X,*BLOCKING EFFECTS AND MAIN EFFECTS*,//,*      INCREMEN
     1TAL ADJUSTED TREATMENT EFFECTS*,///)
      PRINT 502
  502 FORMAT (*                                                    LEVEL*,
     1//,*      FACTOR      1        2         3         4         5        6
     1  7          8         9       10*)
      DO 3 I=1,7
      PRINT 503,I,(OUT(I,J),J=1,10)
  503 FORMAT (7X,I2,4X,10F8.4)
    3 CONTINUE
      RETURN
      END



      FUNCTION RND(NSEED)
      DATA K/30517578125/,SCALE/0.35527136E-14/
      NSEED=NSEED*K
      RND=FLOAT(NSEED)*SCALE
      RETURN
      END



      FUNCTION FNORM(SIGMA,NSEED)
C  COMPUTES NORMAL DEVIATES WITH MEAN ZERO AND STANDARD DEVIATION SIGMA
      DATA K/0/,TWOPI/6.2832/
      IF (K.EQ.1)GO TO 1
      K=1
      FACT1=SQRT(-2.0*ALOG(RND(NSEED)))
      FACT2=TWOPI*RND(NSEED)
      Z=FACT1*SIN(FACT2)
      GO TO 2
```

```
1 K=0
  Z=FACT1*COS(FACT2)
2 FNORM=Z*SIGMA
  RETURN
  END
```

APPENDIX C

SAMPLE INPUT LISTING

The standard deviation for the error component was set to zero for this sample experiment so that one may reconstruct each observation from the various increment effects which are included in order to check the execution of the STEXSIM model.

```
NO PUNCH
2222111222121                 3 3 3   100.0     1        SAMPLE PROBLEM
-3.0          0.0           +3.0
-1.0          0.0           +1.0
-2.0         -1.0           +3.0
-1.0          0.0           +1.0
+3.0         +1.0           -4.0
-5.0         +5.0           +1.2
-5.0         +5.0           [illegible].5
-5.0         +5.0           [illegible].1
-5.0         +5.0           [illegible].4
[illegible].0                533
SAMPLE PROBLEM     MIXED   WITH STUDENT IGNORING FACTOR 7
22[illegible]22222122       9
[illegible] 1 2 3
3 1 2 3
1 1
1 2
1 3
2 1
2 2
2 3
3 1
3 2
3 3
```

Punched output not desired

Factors 5, 6 and 7 are active

Factors 5 and 7 are fixed
6 is random

Factors 5, 6 and 7 are each at 3 levels

overall mean

number of student experiment which follow

not read by computer

Treatment effects for 1st fixed factor (5)

Effects for 2nd fixed Factor (7)

Incremental effects [illegible] first fixed [illegible] interaction ([illegible]-7)

range limits for random components

error standard deviation

Standard deviation for 1st random main effect (6)

standard deviation for 1st two way, random interaction (5-6)

standard deviation for 2nd two way, random interaction (6-7)

Standard deviation for 5-6-7 three way interaction

Seed number for random number generator

student identification card (1st card in student design)

factor 5 is assumed fixed and 6 assumed random

number of observations

student defines factors 5 and 6 active

1st active factor (5) and 2nd active factor (6) are each at 3 levels, 1, 2 and 3

Specification of levels of factors 5 and 6 for each of 9 observations

APPENDIX D

SAMPLE STEXSIM OUTPUT

1. Output for student
2. Output for instructor

1. OUTPUT FOR STUDENT

STUDENT NUMBER 1

Sequence number

```
***********************************************************************
*                                                                     *
* SAMPLE PROBLEM   MIXED   WITH STUDENT [illegible]   IGNORING FACTOR 7 *
*                                                                     *
***********************************************************************
```

OBSERVATION		FACTOR LEVELS 1	2	3	4	5	6	7
1	97.1232	0	0	0	0	1	1	0
2	102.5677	0	0	0	0	1	2	0
3	101.3256	0	0	0	0	[illegible]	3	0
4	103.5114	0	0	0	0	[illegible]	1	0
5	102.5914	0	0	0	0	[illegible]	2	0
6	102.2074	0	0	0	0	[illegible]	3	0
7	105.2749	0	0	0	0	[illegible]	1	0
8	106.1484	0	0	0	0	3	2	0
9	105.6081	0	0	0	0	3	3	0

UNCHED OUTPUT

indicates punched card output not requested

levels of factor 5 and 6 specified by student

STUD OUT

STUDENT NUMBER 1

```
*****************************************************
*
* SAMPLE PROBLEM  MIXED  WITH STUDENT IGNORING FACTOR 7 *
*
*****************************************************
```

Copy of student's output for instructor

	FACTOR LEVELS							
	OBSERVATION	1	2	3	4	5	6	7
1	97.1232	0	0	0	0	1	1	0
2	102.5677	0	0	0	0	1	2	0
3	101.3256	0	0	0	0	1	3	0
4	103.5114	0	0	0	0	2	1	0
5	102.5914	0	0	0	0	2	2	0
6	102.2074	0	0	0	0	2	3	0
7	106.2749	0	0	0	0	3	1	0
8	106.1484	0	0	0	0	3	2	0
9	105.6081	0	0	0	0	3	3	0

NO PUNCHED OUTPUT

FACTORS USED BY MODEL IF DIFFERENT

Included to show levels of factor 7 generated by LEVSEL

	FACTOR LEVELS							
	OBSERVATION	1	2	3	4	5	6	7
1	97.1232	0	0	0	0	1	1	1
2	102.5677	0	0	0	0	1	2	3
3	101.3256	0	0	0	0	1	3	3
4	103.5114	0	0	0	0	2	1	3
5	102.5914	0	0	0	0	2	2	3
6	102.2074	0	0	0	0	2	3	3
7	106.2749	0	0	0	0	3	1	2
8	106.1484	0	0	0	0	3	2	1
9	105.6081	0	0	0	0	3	3	1

INSTRUCTOR INPUT , FACTORS INVOLVED

Instructor's model

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	RANDOM	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED

1	NO					
2	NO					
3	NO					
4	NO					
5	YES	FIXED	3	1	2	3
6	YES	RANDOM	3	1	2	3
7	NO					

Factors defined in student's design

OVERALL AVERAGE

INSTRUCTOR VALUE 100.00 ← defined by instructor
STUDENT VALUE 100.00 ← would have been adjusted if student ignored levels of a fixed factor

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

Incremental Treatment Effects

FACTOR	NO. LEVELS	TRT. EFFECTS level 1	level 2	level 3	
5	3	-3.000	0.000	3.000	— specified by instructor (fixed factor)
6	3	2.364	1.012	-.035	— generated by RTRT (random factor)
7	3	-1.000	0.000	1.000	— specified by instructor (fixed factor)

INSTRUCTOR INPUT
TWO WAY INTERACTION EFFECTS

ROWS-FACTOR 5
COLUMNS-FACTOR 6

ROW (level of factor 5)	TRT. EFFECTS (level 1 of factor 6)	level 2 of factor 6	level 3 of factor 6
1	.065	.033	.713
2	-.101	.275	.457
3	-.316	.035	1.242

Incremental effects for 5-6 interaction — Selected by RINTER from normal distribution with mean zero, $\sigma = 0.5$

ROWS-FACTOR 5
COLUMNS-FACTOR 7

ROW	TRT. EFFECTS		
1	-2.000	-1.000	3.000
2	-1.000	0.000	1.000
3	3.000	1.000	-4.000

Incremental effects for 5-7 interaction -- Specified by instructor since 5 and 7 are both fixed factors.

ROWS-FACTOR 6
COLUMNS-FACTOR 7

ROW	TRT. EFFECTS		
1	.144	-.012	-.164
2	.141	.063	-.318

Increment effects for 6-7 interaction — generated by RINTER from normal distribution with ~~mean zero~~ $\sigma = 0.1$

3	-.134	-.149	.083

INSTRUCTOR INPUT
3-WAY INTERACTION EFFECTS

LEVEL OF FACTOR 5 IS 1

level 1st factor 7 — level 2nd factor 7 — level 3rd factor 7

FACTOR 6 LEVEL	NO. LEVELS FACTOR 7	TRT. EFFECTS		
1	3	.549	.368	-.223
2	3	-.164	-.517	.541
3	3	.529	-.434	-.356

LEVEL OF FACTOR 5 IS 2

FACTOR 6 LEVEL	NO. LEVELS FACTOR 7	TRT. EFFECTS		
1	3	-.392	-.142	-.588
2	3	.197	.030	-.677
3	3	.153	-.612	-.218

LEVEL OF FACTOR 5 IS 3

FACTOR 6 LEVEL	NO. LEVELS FACTOR 7	TRT. EFFECTS		
1	3	.183	.238	.168
2	3	-.040	.279	-.246
3	3	-.466	-.458	.959

Three way (5-6-7) interaction incremental effects. Generated by RINTER from normal distribution with mean zero, σ = 0.4

SIGMA = 0.00000 — for error component

BLOCKING EFFECTS AND MAIN EFFECTS

INCREMENTAL ADJUSTED TREATMENT EFFECTS

Includes only adjusted levels of fixed factors. No adjustment in this design since student used all levels of fixed factors 5 and 7

LEVEL

FACTOR	1	2	3	4	5	6	7	8	9	10
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
4	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
5	-3.0000	0.0000	3.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
7	-1.0000	0.0000	1.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

APPENDIX E

INPUT FOR EXPERIMENTS CONDUCTED

In order to conserve space only the first five observation specifications are included for each of the 30 experiments. The remaining observations are identical in format. The exact numerical value for each can be obtained from the corresponding output listing of Appendix F. The instructor's model and student's design otherwise are exactly as when the experiments were conducted.

```
PUNCH
11222221122222 5 4          40.0       6          MODEL 1
-4.0     -2.0      0.0      +2.0     +4.0
-13.0    0.0     +3.0      +10.0
0.75          533
EXP-1A  STUDENT SPECIFIES SAME MODEL AS INST.  ONE OBSERVATION PER CELL
11222221122222   20
 5 1 2 3 4 5
 4 1 2 3 4
 4 2
 1 2
 4 3
 5 4
 2 3

EXP-1B  STUDENT SPECIFIES SAME MODEL AS INST.  TWO OBSERVATION PER CELL
11222221122222   40
 5 1 2 3 4 5
 4 1 2 3 4
 1 1
 1 1
 1 2
 1 2
 1 3
 1 3

EXP-1C  STUDENT SPECIFIES SAME MODEL AS INST.  THREE OBSERVATIONS PER CELL
11222221122222   60
 5 1 2 3 4 5
 4 1 2 3 4
 4 1
 3 1
 1 1
 1 1
 2 2

EXP-1D  STUDENT SPECIFIES LEVELS OF 1, NONE OF 2, 4 OF 3
12122221212222   20
 5 1 2 3 4 5
 4 1 2 3 4
 4   4
 2   3
 5   2
 4   1
 1   4

EXP-1E  STUDENT SPECIFIES 3 LEVELS OF 1,2,3
11122221112222   27
 3 1 3 5
 3 1 2 3
 3 1 3 5
 1 1 1
 1 1 3
 1 1 5
 1 2 1
 1 2 3
EXP-1F  STUDENT IGNORES FACTORS 1 AND 2 BUT SPECIFIES 4 LEVELS OF 5 AND 6
22221122222112   16
 4 1 2 3 4
 4 1 2 3 4
```

```
        1 1
        1 2
        1 3
        1 4
        2 1

22221122222112          6 4      55.0    5          MODEL 2
-10.     -6.0     -3.0     +5.0     +7.0     +7.0
-3.0     0.0      0.0      +3.0
+3.0     0.0      0.0      -3.0
-2.0     -1.0     +1.0     +2.0
0.0      0.0      0.0      0.0
-1.0     +2.0     -2.0     +1.0
+2.0     0.0      +1.0     -3.0
-2.0     -1.0     0.0      +3.0
 1.25          533
EXP 2A - STUDENT MATCHES INSTRUCTOR LEVELS     1 OBS. PER CELL
22221122222112    24
 6 1 2 3 4 5 6
 4 1 2 3 4
        1 1
        1 2
        1 3
        1 4
        2 1

EXP. 2 B STUDENT MATCHES INSTRUCTOR    2 OBS. PER CELL
22221122222112    48
 6 1 2 3 4 5 6
 4 1 2 3 4
        1 1
        1 2
        1 3
        1 4
        2 1

EXP. 2C - STUDENT MATCHES INSTRUCTOR    3 OBS PER CELL
22221122222112    72
 6 1 2 3 4 5 6
 4 1 2 3 4
        1 1
        1 2
        1 3
        1 4
        1 1

EXP. 2 D  STUDENT MATCHES INSTRUCTOR    4 OBS. PER CELL
22221122222112    96
 6 1 2 3 4 5 6
 4 1 2 3 4
        1 1
        1 2
        1 3
        1 4
        1 1

EXP. 2E - STUDENT USES ONLY 4 LEVELS OF 5 AND IGNORES 6    5 OBS
22221222222122    28
 4 1 2 3 4
        1
        1
```

```
              1
              1
              1
1222112222211210        6 4    55.0    2          MODEL 3
-10.      -6.0     -3.0     +5.0    +7.0    +7.0
-3.0      0.0      0.0      +3.0
+3.0      0.0      0.0      -3.0
-2.0      -1.0     +1.0     +2.0
0.0       0.0      0.0      0.0
-1.0      +2.0     -2.0     +1.0
+2.0      0.0      +1.0     -3.0
-2.0      -1.0     0.0      +3.0
-7.0      +7.0     2.0
0.005         533
EXP 3A - FIXED TWO FACTOR WITH BLOCKING FACTOR WHICH IS IGNORED BY ST'. 2 OBS.
22221122222112    48
 6 1 2 3 4 5 6
 4 1 2 3 4
          1 1
          1 2
          1 3
          1 4
          2 1

EXP 3B - STUDENT USES BLOCKING - - 2 BLOCKING LEVELS - 1 OBS PER CELL
12221122222112    48
 2 1 2
 6 1 2 3 4 5 6
 4 1 2 3 4
 1        6 2
 1        4 2
 1        6 1
 1        2 1
 1        5 3

22221112222111          3 3 3  125.0    6          MODEL 4
-3.0      0.0      +3.0
-10.0     -5.0     +15.0
-1.0      -2.0     +3.0
-1.0      0.0      +1.0
+2.0      +1.0     -3.0
-1.0      -1.0     +2.0
-1.0      0.0      +1.0
+2.0      +1.0     -3.0
-1.0      -1.0     +2.0
-1.0      0.0      +1.0
+2.0      +1.0     -3.0
-1.0      -1.0     +2.0
+3.0      0.0      -3.0
0.0       0.0      0.0
-3.0      0.0       +3.0
0.0       0.0      0.0
0.0       0.0      0.0
0.0       0.0      0.
-3.0      0.0      +3.0
0.0       0.0      0.0
+3.0      0.0      -3.0
0.25          533
EXP. 4A - FIXED THREE WAY - STUDENT MATCHES INST. LEVELS - ONE OBS. PER CELL
22221112222111    27
 3 1 2 3
```

```
 3 1 2 3
 3 1 2 3
         1 2 3
         1 3 1
         1 3 2
         3 2 2
         1 3 3
EXP. 4B - FIXED THREE WAY -  TWO OBS. PER CELL.
22221112222111   54
 3 1 2 3
 3 1 2 3
 3 1 2 3
         1 1 1
         1 1 2
         1 1 3
         1 2 1
         1 2 2
EXP. 4C - FIXED THREE WAY -STUDENT IGNORES FACTOR 5 AND USES 2 LEVELS OF 1-2 OBS
12222111222211   36
 2 1 2
 3 1 2 3
 3 1 2 3
 1         1 1
 1         1 2
 1         1 3
 1         2 1
 1         2 2
EXP 4D. THREE WAY FIXED - STUDENT USES ONLY 2 LEVELS OF EACH FACTOR - 3 OBS.
22221112222111   24
 2 1 3
 2 1 3
 2 1 3
         1 1 1
         1 1 3
         1 3 1
         1 3 3
         3 1 1
EXP 4E. THREE WAY FIXED - STUDENT CALLS FACTOR 5 RANDOM   TWO OBS
22221112222211   54
 3 1 2 3
 3 1 2 3
 3 1 2 3
         1 1 1
         1 1 2
         1 1 3
         1 2 1
         1 2 2
EXP 4F - FIXED THREE WAY - STUDENT CALLS FACTOROR 5 RANDOM- ONE OBS. PER CELL
22221112222211   27
 3 1 2 3
 3 1 2 3
 3 1 2 3
         1 2 3
         1 3 1
         1 3 2
         3 2 2
```

```
        1 3 3

222212122222221010101005180 4  20.0     5          MODEL 3
-10.0   +10.0   2.5
-1.0   +1.0     0.5
 -5.0   +5.0     1.5
0.015        533
EXP 5A -TWO WAY RANDOM - STUDENT MATCHES INSTRUCTOR - ONE OBS. PER CELL
22221212222222   20
 5 1 2 3 4 5
 4 1 2 3 4
         1   1
         1   2
         1   3
         1   4
         2   1

EXP. 5B - TWO WAY RANDOM - STUDENT MATCHES INSTRUCTOR - TWO OBS. PER CELL
22221212222222   40
 5 1 2 3 4 5
 4 1 2 3 4
         4   4
         1   2
         2   1
         4   2
         4   1

EXP. 5C - TWO WAY RANDOM - STDT. USES FACTORS 1 AND 3 RATHER THAN 5 AND 7
12122222222222   20
 5 1 2 3 4 5
 4 1 2 3 4
 1   1
 1   2
 1   3
 1   4
 2   1

EXP. 5D  - TWO WAY RANDOM - STDT. CALLS FACTOR 5 FIXED - 3 LEVELS EACH, 2 OBS.
22221212222122   18
 3 1 3 5
 3 1 2 3
         1   1
         1   1
         1   2
         1   2
         1   3

EXP. 5E-  RANDOM TWO WAY - STD. IGNORES FACTOR 7 AND USES 4 LEVELS OF 5, 4 OBS.
22221222222222   16
 4 1 2 3 4
         1
         2
         3
         4
         1

22221112222121          3 3 3  100.0    2          MODEL 6
-3.0    0.0     +3.0
-1.0    0.0     +1.0
-2.0    -1.0    +3.0
-1.0    0.0     +1.0
```

```
+3.0      +1.0      -4.0
-5.0      +5.0      +1.25
-5.0      +5.0      +0.5
-5.0      +5.0      0.0
-5.0      +5.0      0.0
0.001         533
EXP 6A - MIXED THREE WAY STOT MATCHES INST. MODEL   - 2 OBSERVATIONS
22221112222121   54
 3 1 2 3
 3 1 2 3
 3 1 2 3
          1 1 1
          1 1 2
          1 1 3
          1 2 1
          1 2 2

EXP. 6B - MIXED THREE WAY WHICH STUDENT CALLS FIXED - TWO OBSERVATIONS
22221112222111   54
 3 1 2 3
 3 1 2 3
 3 1 2 3
          1 1 1
          1 1 2
          1 1 3
          1 2 1
          1 2 2

111211222221121010    3 3     75.0    4          MODEL NUMBER 7
-3.0      0.0       +3.0
+2.0      +2.0      -4.0
-2.0      -1.0      +3.0
-1.0      0.0       +1.0
+3.0      +1.0      -4.0
-5.0      +5.0      +1.5
-5.0      +5.0      +1.5
-5.0      +5.0      +1.5
0.01          533
EXP. 7A - STUDENT IGNORES BLOCKING (8 OBSERVATIONS)
22221122222112   72
 3 1 2 3
 3 1 2 3
          1 1
          1 2
          1 3
          2 1
          2 2

EXP. 7B - STUDENT CONSIDERS ONLY BLOCKING FACTOR 1 (4 OBS.)
12221122222112   72
 2 1 2
 3 1 2 3
 3 1 2 3
 1        1 1
 1        1 2
 1        1 3
 1        2 1
 1        2 2

EXP. 7C - STUDENT CONSIDERS BLOCKING FACTORS 1 AND 2 (2 OBS.)
11221122222112   72
```

```
2 1 2
2 1 2
3 1 2 3
3 1 2 3
1 1       1 1
1 1       1 2
1 1       1 3
1 1       2 1
1 1       2 2

EXP. 7D - STUDENT CONSIDERS ALL THREE BLOCKING FACTORS (1  BS.)
1112112222112    72
 2 1 2
 2 1 2
 2 1 2
 3 1 2 3
 3 1 2 3
 1 1 1   1 1
 1 1 1   1 2
 1 1 1   1 3
 1 1 1   2 1
 1 1 1   2 2
```

APPENDIX F

STUDENT OUTPUT FOR EACH OF EXPERIMENTS

In order to present more information to the reader without increasing the number of pages in this report, the output included in this Appendix is that printed for the instructor. Everything after the phrase PUNCHED OUTPUT SPECIFIED would not be printed on the student's copy. The reader in this way can see a portion of the instructor's output whenever the listing of observations terminate above the end of a particular sheet.

STUDENT NUMBER 1

```
**********************************************************************
*                                                                    *
* EXP-1A  STUDENT SPECIFIES SAME MODEL AS INST.  ONE OBSERVATION PER CELL *
*                                                                    *
**********************************************************************
```

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	41.5880	4	2	0	0	0	0	0
2	37.7429	1	2	0	0	0	0	0
3	45.4491	4	3	0	0	0	0	0
4	53.1345	5	4	0	0	0	0	0
5	43.3109	2	3	0	0	0	0	0
6	33.7103	1	3	0	0	0	0	0
7	44.9425	1	4	0	0	0	0	0
8	51.1918	4	4	0	0	0	0	0
9	43.2259	3	2	0	0	0	0	0
10	42.6501	3	3	0	0	0	0	0
11	50.4465	3	4	0	0	0	0	0
12	28.4933	4	1	0	0	0	0	0
13	31.1785	5	1	0	0	0	0	0
14	39.0361	2	2	0	0	0	0	0
15	23.5503	1	1	0	0	0	0	0
16	44.1546	5	2	0	0	0	0	0
17	25.1425	2	1	0	0	0	0	0
18	45.1454	2	4	0	0	0	0	0
19	47.1113	5	3	0	0	0	0	0
20	27.6415	3	1	0	0	0	0	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

Not printed for student

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	YES	FIXED	5
2	YES	FIXED	4
3	NO		
4	NO		
5	NO		
6	NO		
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED				
1	YES	FIXED	5	1	2	3	4	5
2	YES	FIXED	4	1	2	3	4	
3	NO							
4	NO							

STUDENT NUMBER 2

```
****************************************************************************
*                                                                          *
* EXP-18  STUDENT SPECIFIES SAME MODEL AS INST.  TWO OBSERVATION PER CELL  *
*                                                                          *
****************************************************************************
```

FACTOR LEVELS

	OBSERVATION	1	2	3	4	5	6	7
1	22.2566	1	1	0	0	0	0	0
2	23.1589	1	1	0	0	0	0	0
3	37.5244	1	2	0	0	0	0	0
4	35.9119	1	2	0	0	0	0	0
5	33.9336	1	3	0	0	0	0	0
6	41.2383	1	3	0	0	0	0	0
7	46.8928	1	4	0	0	0	0	0
8	46.3475	1	4	0	0	0	0	0
9	25.6272	2	1	0	0	0	0	0
10	25.3549	2	1	0	0	0	0	0
11	37.8467	2	2	0	0	0	0	0
12	33.5129	2	2	0	0	0	0	0
13	41.9476	2	3	0	0	0	0	0
14	44.9349	2	3	0	0	0	0	0
15	47.1563	2	4	0	0	0	0	0
16	45.3131	2	4	0	0	0	0	0
17	26.7191	3	1	0	0	0	0	0
18	27.2541	3	1	0	0	0	0	0
19	33.2395	3	2	0	0	0	0	0
20	33.9111	3	2	0	0	0	0	0
21	43.1494	3	3	0	0	0	0	0
22	41.6574	3	3	0	0	0	0	0
23	49.9355	3	4	0	0	0	0	0
24	49.8574	3	4	0	0	0	0	0
25	28.8672	4	1	0	0	0	0	0
26	27.7649	4	1	0	0	0	0	0
27	41.1873	4	2	0	0	0	0	0
28	42.5254	4	2	0	0	0	0	0
29	43.5110	4	3	0	0	0	0	0
30	45.3303	4	3	0	0	0	0	0
31	51.4905	4	4	0	0	0	0	0
32	51.3282	4	4	0	0	0	0	0
33	30.8972	5	1	0	0	0	0	0
34	31.0747	5	1	0	0	0	0	0
35	44.8180	5	2	0	0	0	0	0
36	43.7341	5	2	0	0	0	0	0
37	46.6124	5	3	0	0	0	0	0
38	46.2469	5	3	0	0	0	0	0
39	54.1909	5	4	0	0	0	0	0
40	54.8434	5	4	0	0	0	0	0

PUNCHED OUTPUT SPECIFIED

STUDENT NUMBER 3

****

* EXP-1C STUDENT SPECIFIES SAME MODEL AS INST. THREE OBSERVATIONS PER CELL *

****

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	28.7233	4	1	0	0	0	0	0
2	27.3614	3	1	0	0	0	0	0
3	24.1158	1	1	0	0	0	0	0
4	23.4931	1	1	0	0	0	0	0
5	35.5341	2	2	0	0	0	0	0
6	45.5520	1	4	0	0	0	0	0
7	33.2170	5	1	0	0	0	0	0
8	52.3975	5	4	0	0	0	0	0
9	49.2779	2	4	0	0	0	0	0
10	25.7857	2	1	0	0	0	0	0
11	38.2750	1	3	0	0	0	0	0
12	43.0306	5	2	0	0	0	0	0
13	35.3381	1	2	0	0	0	0	0
14	38.2597	1	3	0	0	0	0	0
15	49.9556	3	4	0	0	0	0	0
16	42.3124	3	3	0	0	0	0	0
17	44.0560	4	3	0	0	0	0	0
18	46.2977	5	3	0	0	0	0	0
19	53.7536	5	4	0	0	0	0	0
20	31.2148	5	1	0	0	0	0	0
21	47.3073	5	3	0	0	0	0	0
22	49.5033	3	4	0	0	0	0	0
23	39.2553	2	2	0	0	0	0	0
24	39.6115	2	3	0	0	0	0	0
25	44.3122	5	2	0	0	0	0	0
26	52.1050	4	4	0	0	0	0	0
27	48.2366	2	4	0	0	0	0	0
28	28.3762	4	1	0	0	0	0	0
29	43.0156	1	3	0	0	0	0	0
30	27.1128	3	1	0	0	0	0	0
31	43.0634	3	2	0	0	0	0	0
32	21.4730	1	1	0	0	0	0	0
33	41.7018	4	2	0	0	0	0	0
34	35.7025	1	2	0	0	0	0	0
35	52.9709	5	4	0	0	0	0	0
36	46.2217	4	3	0	0	0	0	0
37	45.5041	1	4	0	0	0	0	0
38	43.6983	3	3	0	0	0	0	0
39	25.9670	2	1	0	0	0	0	0
40	43.3832	3	3	0	0	0	0	0
41	54.0158	5	4	0	0	0	0	0
42	43.1953	5	2	0	0	0	0	0
43	41.5093	2	3	0	0	0	0	0
44	45.9034	4	3	0	0	0	0	0
45	42.5443	4	2	0	0	0	0	0
46	29.4515	4	1	0	0	0	0	0
47	31.2454	5	1	0	0	0	0	0

48	39.1796	3	2	0	0	0	0	0
49	24.6478	2	1	0	0	0	0	0
50	40.5172	2	3	0	0	0	0	0
51	42.9939	4	2	0	0	0	0	0
52	39.8711	3	2	0	0	0	0	0
53	35.7567	1	2	0	0	0	0	0
54	46.3761	5	3	0	0	0	0	0
55	26.8357	3	1	0	0	0	0	0
56	47.0546	2	4	0	0	0	0	0
57	36.3325	2	2	0	0	0	0	0
58	46.0736	1	4	0	0	0	0	0
59	52.2364	4	4	0	0	0	0	0
60	51.7436	[illegible]	4	0	0	0	0	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	YES	FIXED	5
2	YES	FIXED	4
3	NO		
4	NO		
5	NO		
6	NO		
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED				
1	YES	FIXED	5	1	2	3	4	5
2	YES	FIXED	4	1	2	3	4	
3	NO							
4	NO							
5	NO							
6	NO							
7	NO							

OVERALL AVERAGE

INSTRUCTOR VALUE 40.00
STUDENT VALUE 40.00

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

FACTOR	NO. LEVELS	TRT. EFFECTS				
1	5	-4.000	-2.000	0.000	2.000	4.000
2	4	-13.000	0.000	3.000	10.000	

STUDENT NUMBER 4

```
**************************************************************
*                                                            *
* EXP-1D  STUDENT SPECIFIES LEVELS OF 1, NONE OF 2, 4 OF 3   *
*                                                            *
**************************************************************
```

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	28.3011	4	0	4	0	0	0	0
2	43.2981	2	0	3	0	0	0	0
3	54.2107	5	0	2	0	0	0	0
4	44.4986	4	0	1	0	0	0	0
5	44.3132	1	0	4	0	0	0	0
6	54.6695	5	0	3	0	0	0	0
7	44.5436	4	0	2	0	0	0	0
8	22.4823	1	0	2	0	0	0	0
9	33.7886	5	0	1	0	0	0	0
10	42.2437	3	0	2	0	0	0	0
11	39.1402	3	0	3	0	0	0	0
12	24.8590	2	0	1	0	0	0	0
13	47.7794	2	0	4	0	0	0	0
14	42.8866	3	0	1	0	0	0	0
15	41.4316	4	0	3	0	0	0	0
16	46.1239	1	0	3	0	0	0	0
17	25.7343	3	0	4	0	0	0	0
18	45.1727	1	0	1	0	0	0	0
19	53.3129	5	0	4	0	0	0	0
20	41.3692	2	0	2	0	0	0	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	28.3011	4	1	4	0	0	0	0
2	43.2981	2	3	3	0	0	0	0
3	54.2107	5	4	2	0	0	0	0
4	44.4986	4	3	1	0	0	0	0
5	44.3132	1	4	4	0	0	0	0
6	54.6695	5	4	3	0	0	0	0
7	44.5436	4	3	2	0	0	0	0
8	22.4823	1	1	2	0	0	0	0
9	33.7886	5	1	1	0	0	0	0
10	42.2437	3	3	2	0	0	0	0
11	39.1402	3	2	3	0	0	0	0
12	24.8596	2	1	1	0	0	0	0
13	47.7794	2	4	4	0	0	0	0
14	42.8866	3	3	1	0	0	0	0
15	41.4316	4	2	3	0	0	0	0
16	46.1239	1	4	3	0	0	0	0
17	25.7343	3	1	4	0	0	0	0
18	45.1727	1	4	1	0	0	0	0
19	53.3129	5	4	4	0	0	0	0

STUDENT NUMBER 5

```
******************************************************
*                                                    *
* EXP-1E  STUDENT SPECIFIES 3 LEVELS OF 1,2,3        *
*                                                    *
******************************************************
```

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	21.7109	1	1	1	0	0	0	0
2	22.2372	1	1	3	0	0	0	0
3	23.8550	1	1	5	0	0	0	0
4	37.4495	1	2	1	0	0	0	0
5	36.1438	1	2	3	0	0	0	0
6	35.2699	1	2	5	0	0	0	0
7	39.6501	1	3	1	0	0	0	0
8	37.8689	1	3	3	0	0	0	0
9	35.4007	1	3	5	0	0	0	0
10	26.1157	3	1	1	0	0	0	0
11	26.5537	3	1	3	0	0	0	0
12	27.4454	3	1	5	0	0	0	0
13	39.1997	3	2	1	0	0	0	0
14	39.3324	3	2	3	0	0	0	0
15	39.5339	3	2	5	0	0	0	0
16	44.0798	3	3	1	0	0	0	0
17	42.3912	3	3	3	0	0	0	0
18	43.5233	3	3	5	0	0	0	0
19	31.0013	5	1	1	0	0	0	0
20	33.9575	5	1	3	0	0	0	0
21	31.3365	5	1	5	0	0	0	0
22	45.8937	5	2	1	0	0	0	0
23	43.5510	5	2	3	0	0	0	0
24	43.2373	5	2	5	0	0	0	0
25	46.3223	5	3	1	0	0	0	0
26	47.1836	5	3	3	0	0	0	0
27	47.0900	5	3	5	0	0	0	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	YES	FIXED	5
2	YES	FIXED	4
3	NO		
4	NO		
5	NO		
6	NO		
7	NO		

STUDENT INPUT , FACTORS US...

STUDENT NUMBER 6

```
**********************************************************************************
*                                                                                *
* EXP-1F  STUDENT IGNORES FACTORS 1 AND 2 BUT SPECIFIES 4 LEVELS OF 5 AND 6     *
*                                                                                *
**********************************************************************************
```

FACTOR LEVELS

	OBSERVATION	1	2	3	4	5	6	7
1	52.2256	0	0	0	0	1	1	0
2	45.9306	0	0	0	0	1	2	0
3	51.2334	0	0	0	0	1	3	0
4	41.7168	0	0	0	0	1	4	0
5	29.9375	0	0	0	0	2	1	0
6	54.5070	0	0	0	0	2	2	0
7	37.9307	0	0	0	0	2	3	0
8	41.6658	0	0	0	0	2	4	0
9	35.6320	0	0	0	0	3	1	0
10	51.5730	0	0	0	0	3	2	0
11	36.1690	0	0	0	0	3	3	0
12	23.2277	0	0	0	0	3	4	0
13	42.1044	0	0	0	0	4	1	0
14	45.5641	0	0	0	0	4	2	0
15	40.7449	0	0	0	0	4	3	0
16	44.6387	0	0	0	0	4	4	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

FACTOR LEVELS

	OBSERVATION	1	2	3	4	5	6	7
1	52.2256	4	4	0	0	1	1	0
2	45.9306	1	4	0	0	1	2	0
3	51.2344	3	4	0	0	1	3	0
4	41.7168	4	2	0	0	1	4	0
5	29.9375	4	1	0	0	2	1	0
6	54.5370	5	4	0	0	2	2	0
7	37.9307	2	2	0	0	2	3	0
8	41.6358	3	3	0	0	2	4	0
9	35.6320	1	2	0	0	3	1	0
10	51.5730	4	4	0	0	3	2	0
11	36.1693	1	2	0	0	3	3	0
12	23.2277	1	1	0	0	3	4	0
13	42.1044	4	2	0	0	4	1	0
14	45.5641	5	3	0	0	4	2	0
15	43.7449	2	3	0	0	4	3	0
16	44.6387	4	3	0	0	4	4	0

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR ACTIVE TYPE NO. LEVELS

STUDENT NUMBER 1

```
*****************************************************************
*                                                               *
* EXP 2A - STUDENT MATCHES INSTRUCTOR LEVELS     1 OBS. PER CELL *
*                                                               *
*****************************************************************
```

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	44.3134	0	0	0	0	1	1	0
2	47.9[illegible]4[illegible]	0	0	0	0	1	2	0
3	45.7485	0	0	0	0	1	3	0
4	43.5[illegible]74	0	0	0	0	1	4	0
5	43.5543	0	0	0	0	2	1	0
6	47.5[illegible]	0	0	0	0	2	2	0
7	46.2175	0	0	0	0	2	3	0
8	52.653[illegible]	0	0	0	0	2	4	0
9	43.373[illegible]	0	0	0	0	3	1	0
10	51.[illegible]	0	0	0	0	3	2	0
11	52.7[illegible]	0	0	0	0	3	3	0
12	54.1355	0	0	0	0	3	4	[illegible]
13	54.63[illegible]	0	0	0	0	4	1	0
14	53.[illegible]	0	0	0	0	4	2	0
15	55.[illegible]	0	0	0	0	4	3	0
16	64.2577	0	0	0	0	4	4	0
17	61.2375	0	0	0	0	5	1	0
18	62.2423	0	0	0	0	5	2	0
19	63.3[illegible]	0	0	0	0	5	3	0
20	63.0533	0	0	0	0	5	4	0
21	55.751[illegible]	0	0	0	0	6	1	0
22	61.2815	0	0	0	0	6	2	0
23	64.5[illegible]7	0	0	0	0	6	3	0
24	69.5196	0	0	0	0	6	4	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	6
6	YES	FIXED	4
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED

STUDENT NUMBER 2

****
* EXP. 2 B STUDENT MATCHES INSTRUCTOR 2 OBS. PER CELL *
****

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	47.6361	0	0	0	0	1	1	0
2	46.3431	0	0	0	0	1	2	0
3	45.4971	0	0	0	0	1	3	0
4	43.6126	0	0	0	0	1	4	0
5	44.6336	0	0	0	0	2	1	0
6	43.3547	0	0	0	0	2	2	0
7	43.6338	0	0	0	0	2	3	0
8	54.6655	0	0	0	0	2	4	0
9	50.5140	0	0	0	0	3	1	0
10	52.9071	0	0	0	0	3	2	0
11	52.7525	0	0	0	0	3	3	0
12	55.4189	0	0	0	0	3	4	0
13	54.6327	0	0	0	0	4	1	0
14	61.4131	0	0	0	0	4	2	0
15	57.1554	0	0	0	0	4	3	0
16	65.6565	0	0	0	0	4	4	0
17	63.7852	0	0	0	0	5	1	0
18	61.3945	0	0	0	0	5	2	0
19	61.4682	0	0	0	0	5	3	0
20	61.7465	0	0	0	0	5	4	0
21	65.4243	0	0	0	0	6	1	0
22	61.5541	0	0	0	0	6	2	0
23	61.1116	0	0	0	0	6	3	0
24	63.3941	0	0	0	0	6	4	0
25	44.5611	0	0	0	0	1	1	0
26	43.1351	0	0	0	0	1	2	0
27	43.8512	0	0	0	0	1	3	0
28	45.3745	0	0	0	0	1	4	0
29	43.1643	0	0	0	0	2	1	0
30	45.1697	0	0	0	0	2	2	0
31	51.1159	0	0	0	0	2	3	0
32	53.2346	0	0	0	0	2	4	0
33	48.1372	0	0	0	0	3	1	0
34	51.6476	0	0	0	0	3	2	0
35	53.7356	0	0	0	0	3	3	0
36	53.5670	0	0	0	0	3	4	0
37	55.7651	0	0	0	0	4	1	0
38	61.6324	0	0	0	0	4	2	0
39	57.8277	0	0	0	0	4	3	0
40	63.0519	0	0	0	0	4	4	0
41	61.2065	0	0	0	0	5	1	0
42	61.5071	0	0	0	0	5	2	0
43	61.5212	0	0	0	0	5	3	0
44	61.6861	0	0	0	0	5	4	0
45	57.6154	0	0	0	0	6	1	0
46	58.8515	0	0	0	0	6	2	0
47	61.7286	0	0	0	0	6	3	0

```
48   69.4250     0     0     0     [illegible]     6     4     0
```

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	6
6	YES	FIXED	4
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED					
1	NO								
2	NO								
3	NO								
4	NO								
5	YES	FIXED	6	1	2	3	4	5	6
6	YES	FIXED	4	1	2	3	4		
7	NO								

OVERALL AVERAGE

INSTRUCTOR VALUE	55.00
STUDENT VALUE	55.00

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

FACTOR	NO. LEVELS	TRT. EFFECTS					
5	6	-10.000	-6.000	-3.[illegible]	5.000	7.000	7.000
6	4	-3.000	0.000	0.[illegible]	3.000		

INSTRUCTOR INPUT
TWO WAY INTERACTION EFFECTS

ROWS-FACTOR 5
COLUMNS-FACTOR 6

ROW	TRT. EFFECTS			
1	3.000	0.000	0.000	-3.000

STUDENT NUMBER 2

EXP. 2C - STUDENT MATCHES INSTRUCTOR 3 OBS PE CELL

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	44.8583	0	0	0	0	1	1	0
2	47.1466	0	0	0	0	1	2	0
3	45.1547	0	0	0	0	1	3	0
4	45.5791	0	0	0	0	1	4	0
5	46.0454	0	0	0	0	1	1	0
6	45.4248	0	0	0	0	1	2	0
7	44.7445	0	0	0	0	1	3	0
8	45.8549	0	0	0	0	1	4	0
9	44.9126	0	0	0	0	1	1	0
10	44.3315	0	0	0	0	1	2	0
11	43.6505	0	0	0	0	1	3	0
12	45.5166	0	0	0	0	1	4	0
13	43.5361	0	0	0	0	2	1	0
14	43.4235	0	0	0	0	2	2	0
15	45.7325	0	0	0	0	2	3	0
16	52.1352	0	0	0	0	2	4	0
17	44.2484	0	0	0	0	2	1	0
18	46.3955	0	0	0	0	2	2	0
19	49.5524	0	0	0	0	2	3	0
20	53.7623	0	0	0	0	2	4	0
21	43.[illegible]	0	0	0	0	2	1	0
22	45.9414	0	0	0	0	2	2	0
23	43.5121	0	0	0	0	2	3	0
24	54.8757	0	0	0	0	2	4	0
25	46.5184	0	0	0	0	3	1	0
26	52.5506	0	0	0	0	3	2	0
27	51.1503	0	0	0	0	3	3	0
28	53.5603	0	0	0	0	3	4	0
29	48.5287	0	0	0	0	3	1	0
30	52.1245	0	0	0	0	3	2	0
31	53.3634	0	0	0	0	3	3	0
32	54.5569	0	0	0	0	3	4	0
33	46.3540	0	0	0	0	3	1	0
34	50.7449	0	0	0	0	3	2	0
35	52.3181	0	0	0	0	3	3	0
36	55.0723	0	0	0	0	3	4	0
37	55.5339	0	0	0	0	4	1	0
38	62.1323	0	0	0	0	4	2	0
39	59.6596	0	0	0	0	4	3	0
40	64.8052	0	0	0	0	4	4	0
41	56.8921	0	0	0	0	4	1	0
42	62.92[illegible]	0	0	0	0	4	2	0
43	56.6950	0	0	0	0	4	3	0
44	62.3292	0	0	0	0	4	4	0
45	58.1299	0	0	0	0	4	1	0
46	63.3054	0	0	0	0	4	2	0
47	56.7917	0	0	0	0	4	3	0

48	62.4676	0	0	0	0	4	4	0
49	59.6968	0	0	0	0	5	1	0
50	60.4495	0	0	0	0	5	2	0
51	62.9426	0	0	0	0	5	3	0
52	60.6540	0	0	0	0	5	4	0
53	59.4267	0	0	0	0	5	1	0
54	60.8296	0	0	0	0	5	2	0
55	64.2644	0	0	0	0	5	3	0
56	62.3580	0	0	0	0	5	4	0
57	61.5122	0	0	0	0	5	1	0
58	61.1671	0	0	0	0	5	2	0
59	63.4256	0	0	0	0	5	3	0
60	60.0191	0	0	0	0	5	4	0
61	57.5203	0	0	0	0	6	1	0
62	61.1750	0	0	0	0	6	2	0
63	62.4776	0	0	0	0	6	3	0
64	64.6271	0	0	0	0	6	4	0
65	58.6927	0	0	0	0	6	1	0
66	61.1379	0	0	0	0	6	2	0
67	62.1117	0	0	0	0	6	3	0
68	65.4550	0	0	0	0	6	4	0
69	56.5030	0	0	0	0	6	1	0
70	60.5341	0	0	0	0	6	2	0
71	60.2349	0	0	0	0	6	3	0
72	70.0361	0	0	0	0	6	4	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	6
6	YES	FIXED	4
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED					
1	NO								
2	NO								
3	NO								
4	NO								
5	YES	FIXED	6	1	2	3	4	5	6
6	YES	FIXED	4	1	2	3	4		
7	NO								

OVERALL AVERAGE

INSTRUCTOR VALUE 55.80
STUDENT VALUE 55.00

STUDENT NUMBER 1

****
* EXP. 2 D STUDENT MATCHES INSTRUCTOR 4 OBS. PER CELL *
****

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	43.7286	0	0	0	0	1	1	0
2	44.3134	0	0	0	0	1	2	0
3	47.9348	0	0	0	0	1	3	0
4	45.7485	0	0	0	0	1	4	0
5	43.5174	0	0	0	0	1	1	0
6	44.6348	0	0	0	0	1	2	0
7	44.5181	0	0	0	0	1	3	0
8	43.2375	0	0	0	0	1	4	0
9	43.6539	0	0	0	0	1	1	0
10	45.3765	0	0	0	0	1	2	0
11	44.4668	0	0	0	0	1	3	0
12	45.7342	0	0	0	0	1	4	0
13	43.1555	0	0	0	0	2	1	0
14	46.6378	0	0	0	0	2	2	0
15	51.8131	0	0	0	0	2	3	0
16	55.4838	0	0	0	0	2	4	0
17	44.2577	0	0	0	0	2	1	0
18	[illegible]	0	0	0	0	2	2	0
19	[illegible]	0	0	0	0	2	3	0
20	54.3130	0	0	0	0	2	4	0
21	45.3693	0	0	0	0	2	1	0
22	46.7610	0	0	0	0	2	2	0
23	50.2815	0	0	0	0	2	3	0
24	56.5437	0	0	0	0	2	4	0
25	53.5198	0	0	0	0	3	1	0
26	51.8333	0	0	0	0	3	2	0
27	54.1466	0	0	0	0	3	3	0
28	55.1547	0	0	0	0	3	4	0
29	49.5791	0	0	0	0	3	1	0
30	53.0454	0	0	0	0	3	2	0
31	53.4248	0	0	0	0	3	3	0
32	54.7445	0	0	0	0	3	4	0
33	49.3549	0	0	0	0	3	1	0
34	51.9126	0	0	0	0	3	2	0
35	51.8915	0	0	0	0	3	3	0
36	53.6605	0	0	0	0	3	4	0
37	55.5168	0	0	0	0	4	1	0
38	61.5301	0	0	0	0	4	2	0
39	58.4235	0	0	0	0	4	3	0
40	62.7325	0	0	0	0	4	4	0
41	54.1552	0	0	0	0	4	1	0
42	52.2484	0	0	0	0	4	2	0
43	56.3956	0	0	0	0	4	3	0
44	63.8924	0	0	0	0	4	4	0
45	55.7523	0	0	0	0	4	1	0
46	61.7786	0	0	0	0	4	2	0
47	55.9414	0	0	0	0	4	3	0

48	62.5121	0	0	0	0	4	4	0
49	61.8757	0	0	0	0	5	1	0
50	59.5184	0	0	0	0	5	2	0
51	63.5506	0	0	0	0	5	3	0
52	61.1598	0	0	0	0	5	4	0
53	59.6923	0	0	0	0	5	1	0
54	61.8287	0	0	0	0	5	2	0
55	63.1245	0	0	0	0	5	3	0
56	63.3634	0	0	0	0	5	4	0
57	60.5569	0	0	0	0	5	1	0
58	61.3540	0	0	0	0	5	2	0
59	61.7449	0	0	0	0	5	3	0
60	62.3131	0	0	0	0	5	4	0
61	57.0723	0	0	0	0	6	1	0
62	60.5339	0	0	0	0	6	2	0
63	62.1023	0	0	0	0	6	3	0
64	69.8558	0	0	0	0	6	4	0
65	57.8052	0	0	0	0	6	1	0
66	61.3921	0	0	0	0	6	2	0
67	62.92[illegible]1	0	0	0	0	6	3	0
68	66.6951	0	0	0	0	6	4	0
69	55.3232	0	0	0	0	6	1	0
70	63.1293	0	0	0	0	6	2	0
71	53.3[illegible]	0	0	0	0	6	3	0
72	65.7917	0	0	0	0	6	4	0
73	43.4675	0	0	0	0	1	1	0
74	43.8963	0	0	0	0	1	2	0
75	43.4495	0	0	0	0	1	3	0
76	44.9426	0	0	0	0	1	4	0
77	42.8540	0	0	0	0	2	1	0
78	46.4267	0	0	0	0	2	2	0
79	48.8296	0	0	0	0	2	3	0
80	55.2644	0	0	0	0	2	4	0
81	49.3533	0	0	0	0	3	1	0
82	52.5122	0	0	0	0	3	2	0
83	51.1671	0	0	0	0	3	3	0
84	55.4256	0	0	0	0	3	4	0
85	54.3191	0	0	0	0	4	1	0
86	62.5233	0	0	0	0	4	2	0
87	58.1750	0	0	0	0	4	3	0
88	64.4776	0	0	0	0	4	4	0
89	57.6271	0	0	0	0	5	1	0
90	53.6927	0	0	0	0	5	2	0
91	63.1879	0	0	0	0	5	3	0
92	62.1107	0	0	0	0	5	4	0
93	54.4550	0	0	0	0	6	1	0
94	60.5330	0	0	0	0	6	2	0
95	61.5041	0	0	0	0	6	3	0
96	66.2849	0	0	0	0	6	4	0

PUNCHED OUTPUT SPECIFIED

STUDENT NUMBER 3	* EXP. 2E - STUDENT USES ONLY 4 LEVELS OF 5 AND IGNORES 6 5 OBS *

	FACTOR LEVELS							
	OBSERVATION	1	2	3	4	5	6	7
1	47.4159	0	0	0	0	1	0	0
2	45.2396	0	0	0	0	1	0	0
3	43.7931	0	0	0	0	1	0	0
4	46.3536	0	0	0	0	1	0	0
5	43.1148	0	0	0	0	1	0	0
6	53.0111	0	0	0	0	2	0	0
7	46.5279	0	0	0	0	2	0	0
8	49.9729	0	0	0	0	2	0	0
9	43.7424	0	0	0	0	2	0	0
10	52.6661	0	0	0	0	2	0	0
11	51.9373	0	0	0	0	3	0	0
12	43.2232	0	0	0	0	3	0	0
13	53.7997	0	0	0	0	3	0	0
14	50.9853	0	0	0	0	3	0	0
15	52.9756	0	0	0	0	3	0	0
16	55.0031	0	0	0	0	4	0	0
17	61.9292	0	0	0	0	4	0	0
18	56.5609	0	0	0	0	4	0	0
19	61.1561	0	0	0	0	4	0	0
20	61.4349	0	0	0	0	4	0	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

	FACTOR LEVELS							
	OBSERVATION	1	2	3	4	5	6	7
1	47.4159	0	0	0	0	1	4	0
2	45.2396	0	0	0	0	1	4	0
3	43.7931	0	0	0	0	1	4	0
4	46.3536	0	0	0	0	1	2	0
5	43.1148	0	0	0	0	1	1	0
6	53.0111	0	0	0	0	2	4	0
7	46.5279	0	0	0	0	2	2	0
8	49.9729	0	0	0	0	2	3	0
9	43.7424	0	0	0	0	2	2	0
10	52.6661	0	0	0	0	2	4	0
11	51.9373	0	0	0	0	3	2	0
12	43.2232	0	0	0	0	3	1	0
13	53.7997	0	0	0	0	3	2	0
14	50.9853	0	0	0	0	3	3	0
15	52.9756	0	0	0	0	3	3	0
16	55.0031	0	0	0	0	4	3	0
17	61.9292	0	0	0	0	4	2	0
18	56.5609	0	0	0	0	4	1	0
19	61.1561	0	0	0	0	4	3	0

STUDENT NUMBER 1

* EXP 3A - FIXED TWO FACTOR WITH BLOCKING FACTOR WHICH IS IGNORED BY STD. 2 OBS. *

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	49.7334	0	0	0	0	1	1	0
2	[illegible]	0	0	0	0	1	2	0
3	[illegible]	0	0	0	0	1	3	0
4	[illegible]	0	0	0	0	1	4	0
5	[illegible]	0	0	0	0	2	1	0
6	[illegible]	0	0	0	0	2	2	0
7	[illegible]	0	0	0	0	2	3	0
8	[illegible]	0	0	0	0	2	4	0
9	[illegible]	0	0	0	0	3	1	0
10	[illegible]	0	0	0	0	3	2	0
11	[illegible]	0	0	0	0	3	3	0
12	[illegible]	0	0	0	0	3	4	0
13	[illegible]	0	0	0	0	4	1	0
14	[illegible]	0	0	0	0	4	2	0
15	[illegible]	0	0	0	0	4	3	0
16	55.5721	0	0	0	0	4	4	0
17	62.5196	0	0	0	0	5	1	0
18	[illegible]	0	0	0	0	5	2	0
19	[illegible]	0	0	0	0	5	3	0
20	[illegible]	0	0	0	0	5	4	0
21	[illegible]	0	0	0	0	6	1	0
22	[illegible]	0	0	0	0	6	2	0
23	62.1583	0	0	0	0	6	3	0
24	[illegible]	0	0	0	0	6	4	0
25	[illegible]	0	0	0	0	1	1	0
26	[illegible]	0	0	0	0	1	2	0
27	[illegible]	0	0	0	0	1	3	0
28	[illegible]	0	0	0	0	1	4	0
29	47.7873	0	0	0	0	2	1	0
30	48.4238	0	0	0	0	2	2	0
31	53.7821	0	0	0	0	2	3	0
32	55.8221	0	0	0	0	2	4	0
33	49.4176	0	0	0	0	3	1	0
34	[illegible]	0	0	0	0	3	2	0
35	51.9353	0	0	0	0	3	3	0
36	55.3626	0	0	0	0	3	4	0
37	57.9692	0	0	0	0	4	1	0
38	63.9728	0	0	0	0	4	2	0
39	59.9650	0	0	0	0	4	3	0
40	54.2544	0	0	0	0	4	4	0
41	62.6196	0	0	0	0	5	1	0
42	63.9635	0	0	0	0	5	2	0
43	62.9442	0	0	0	0	5	3	0
44	62.4172	0	0	0	0	5	4	0
45	57.2608	0	0	0	0	6	1	0
46	61.3525	0	0	0	0	6	2	0
47	61.8508	0	0	0	0	6	3	0

48 69.6221 0 0 0 0 6 4 0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

		FACTOR LEVELS						
OBSERVATION		1	2	3	4	5	6	7
1	48.7804	1	0	0	0	1	1	0
2	45.4297	7	0	0	0	1	2	0
3	46.9741	10	0	0	0	1	3	0
4	45.3542	8	0	0	0	1	4	0
5	45.9698	10	0	0	0	2	1	0
6	49.9692	10	0	0	0	2	2	0
7	50.4111	7	0	0	0	2	3	0
8	53.9352	3	0	0	0	2	4	0
9	51.7346	1	0	0	0	3	1	0
10	52.4150	7	0	0	0	3	2	0
11	51.6597	5	0	0	0	3	3	0
12	54.9412	3	0	0	0	3	4	0
13	57.9556	10	0	0	0	4	1	0
14	62.3550	8	0	0	0	4	2	0
15	57.9439	3	0	0	0	4	3	0
16	65.9721	10	0	0	0	4	4	0
17	62.6196	2	0	0	0	5	1	0
18	63.9791	10	0	0	0	5	2	0
19	63.8858	9	0	0	0	5	3	0
20	62.3650	8	0	0	0	5	4	0
21	57.4132	7	0	0	0	6	1	0
22	62.5195	2	0	0	0	6	2	0
23	58.1588	6	0	0	0	6	3	0
24	60.[illegible]	7	0	0	0	6	4	0
25	45.3003	8	0	0	0	1	1	0
26	46.9997	10	0	0	0	1	2	0
27	44.9452	3	0	0	0	1	3	0
28	45.1510	6	0	0	0	1	4	0
29	47.7973	1	0	0	0	2	1	0
30	48.4835	7	0	0	0	2	2	0
31	53.7321	1	0	0	0	2	3	0
32	55.6221	2	0	0	0	2	4	0
33	49.4173	7	0	0	0	3	1	0
34	53.9787	10	0	0	0	3	2	0
35	51.9393	3	0	0	0	3	3	0
36	55.3628	8	0	0	0	3	4	0
37	57.9692	10	0	0	0	4	1	0
38	63.9738	10	0	0	0	4	2	0
39	59.9600	10	0	0	0	4	3	0
40	64.2544	4	0	0	0	4	4	0
41	62.6133	2	0	0	0	5	1	0
42	63.9635	10	0	0	0	5	2	0
43	62.9442	3	0	0	0	5	3	0
44	62.4172	7	0	0	0	5	4	0
45	57.2813	4	0	0	0	6	1	0
46	61.3525	8	0	0	0	6	2	0
47	61.5503	5	0	0	0	6	3	0
48	69.6221	2	0	0	0	6	4	0

INSTRUCTOR INPUT , FACTORS INVOLVED

STUDENT NUMBER 2

* EXP 38 - STUDENT USES BLOCKING - - 2 BLOCKING LEVELS - 1 OBS PER CELL *

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	59.5733	1	0	0	0	6	2	0
2	[illegible]	1	0	0	0	4	2	0
3	55.8459	1	0	0	0	6	1	0
4	42.8446	1	0	0	0	2	1	0
5	51.8466	1	0	0	0	5	3	0
6	60.5435	1	0	0	0	5	2	0
7	[illegible]	1	0	0	0	3	2	0
8	[illegible]	1	0	0	0	4	3	0
9	43.5027	1	0	0	0	1	4	0
10	66.5442	1	0	0	0	6	4	0
11	54.6525	1	0	0	0	4	1	0
12	43.5496	1	0	0	0	1	3	0
13	48.5474	1	0	0	0	2	3	0
14	53.6407	1	0	0	0	3	3	0
15	62.6357	1	0	0	0	4	4	0
16	45.6515	1	0	0	0	2	2	0
17	46.5525	1	0	0	0	1	2	0
18	52.6529	1	0	0	0	2	4	0
19	43.5446	1	0	0	0	1	1	0
20	47.6426	1	0	0	0	3	1	0
21	61.5578	1	0	0	0	6	3	0
22	53.5544	1	0	0	0	3	4	0
23	60.5444	1	0	0	0	5	4	0
24	55.6431	1	0	0	0	5	1	0
25	62.4033	2	0	0	0	5	4	0
26	63.4065	2	0	0	0	5	3	0
27	52.4124	2	0	0	0	3	3	0
28	57.4081	2	0	0	0	6	1	0
29	50.4064	2	0	0	0	2	3	0
30	45.4053	2	0	0	0	1	4	0
31	52.4177	2	0	0	0	3	2	0
32	44.4141	2	0	0	0	2	1	0
33	45.4147	2	0	0	0	1	3	0
34	45.4093	2	0	0	0	1	1	0
35	61.4144	2	0	0	0	5	1	0
36	68.4047	2	0	0	0	6	4	0
37	62.4147	2	0	0	0	4	2	0
38	61.4134	2	0	0	0	6	2	0
39	54.4146	2	0	0	0	2	4	0
40	55.3992	2	0	0	0	3	4	0
41	45.4194	2	0	0	0	1	2	0
42	49.4134	2	0	0	0	3	1	0
43	48.4131	2	0	0	0	2	2	0
44	64.4025	2	0	0	0	4	4	0
45	56.4107	2	0	0	0	4	1	0
46	58.4107	2	0	0	0	4	3	0
47	62.4058	2	0	0	0	6	3	0

48	62.4208	2	0	8	0	5	2	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	YES	RANDOM	10
2	NO		
3	NO		
4	NO		
5	YES	FIXED	6
6	YES	FIXED	4
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED					
1	YES	RANDOM	2	1	2				
2	NO								
3	NO								
4	NO								
5	YES	FIXED	6	1	2	3	4	5	6
6	YES	FIXED	4	1	2	3	4		
7	NO								

OVERALL AVERAGE

INSTRUCTOR VALUE	55.00
STUDENT VALUE	55.00

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

FACTOR	NO. LEVELS	TRT. EFFECTS									
1	10	-1.151	.413	1.718	.629	-.869	.142	-1.202	1.252	.181	-.255
5	6	-10.000	-6.000	-3.000	5.000	7.000	7.000				
6	4	-3.000	0.000	0.000	3.000						

INSTRUCTOR INPUT
TWO WAY INTERACTION EFFECTS

ROWS-FACTOR 5
COLUMNS-FACTOR 6

ROW TRT. EFFECTS

STUDENT NUMBER 1

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*************************************************************************
*                                                                       *
* EXP. 4A - FIXED THREE WAY - STUDENT MATCHES INST. LEVELS - ONE OBS. PER CELL *
*                                                                       *
*************************************************************************
```

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	117.3627	0	0	0	0	1	2	3
2	132.5528	0	0	0	0	1	3	1
3	133.1497	0	0	0	0	1	3	2
4	129.7015	0	0	0	0	3	2	2
5	146.9370	0	0	0	0	1	3	3
6	148.9636	0	0	0	0	3	3	3
7	118.6475	0	0	0	0	2	1	1
8	119.7318	0	0	0	0	3	1	3
9	111.[illegible]	0	0	0	0	3	2	1
10	117.5534	0	0	0	0	2	2	3
11	124.1465	0	0	0	0	3	2	3
12	136.2311	0	0	0	0	2	3	1
13	118.7262	0	0	0	0	1	2	1
14	113.3811	0	0	0	0	2	1	2
15	113.0163	0	0	0	0	1	1	3
16	113.0515	0	0	0	0	2	1	3
17	145.0473	0	0	0	0	3	3	1
18	135.0485	0	0	0	0	2	3	2
19	139.0636	0	0	0	0	2	3	3
20	141.2139	0	0	0	0	3	3	2
21	123.7522	0	0	0	0	2	2	1
22	111.[illegible]	0	0	0	0	3	1	1
23	[illegible]	0	0	0	0	3	1	2
24	111.[illegible]	0	0	0	0	1	1	1
25	123.9777	0	0	0	0	2	2	2
26	109.4293	0	0	0	0	1	1	2
27	116.0309	0	0	0	0	1	2	2

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	FIXED	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

STUDENT NUMBER 2

****

EXP. 43 - FIXED THREE WAY - TWO OBS. PER CELL

****

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	111.1156	0	0	0	0	1	1	1
2	109.2891	0	0	0	0	1	1	2
3	113.2350	0	0	0	0	1	1	3
4	116.9459	0	0	0	0	1	2	1
5	115.2710	0	0	0	0	1	2	2
6	117.9825	0	0	0	0	1	2	3
7	131.9783	0	0	0	0	1	3	1
8	134.7821	0	0	0	0	1	3	2
9	147.1134	0	0	0	0	1	3	3
10	110.9365	0	0	0	0	1	1	1
11	139.3847	0	0	0	0	1	1	2
12	112.7465	0	0	0	0	1	1	3
13	116.8370	0	0	0	0	1	2	1
14	115.6497	0	0	0	0	1	2	2
15	117.8191	0	0	0	0	1	2	3
16	131.9765	0	0	0	0	1	3	1
17	134.9525	0	0	0	0	1	3	2
18	145.3357	0	0	0	0	1	3	3
19	113.5683	0	0	0	0	2	1	1
20	[illegible]	0	0	0	0	2	1	2
21	116.1781	0	0	0	0	2	1	3
22	123.5737	0	0	0	0	2	2	1
23	121.1101	0	0	0	0	2	2	2
24	117.8302	0	0	0	0	2	2	3
25	136.7761	0	0	0	0	2	3	1
26	134.9657	0	0	0	0	2	3	2
27	139.0249	0	0	0	0	2	3	3
28	117.2127	0	0	0	0	2	1	1
29	115.9114	0	0	0	0	2	1	2
30	117.[illegible]	0	0	0	0	2	1	3
31	123.7490	0	0	0	0	2	2	1
32	121.0336	0	0	0	0	2	2	2
33	110.0145	0	0	0	0	2	2	3
34	136.9368	0	0	0	0	2	3	1
35	135.0235	0	0	0	0	2	3	2
36	133.3719	0	0	0	0	2	3	3
37	111.1510	0	0	0	0	3	1	1
38	114.1760	0	0	0	0	3	1	2
39	126.1840	0	0	0	0	3	1	3
40	121.7390	0	0	0	0	3	2	1
41	119.3650	0	0	0	0	3	2	2
42	124.4360	0	0	0	0	3	2	3
43	145.2519	0	0	0	0	3	3	1
44	140.7563	0	0	0	0	3	3	2
45	148.6935	0	0	0	0	3	3	3
46	110.7794	0	0	0	0	3	1	1
47	113.6399	0	0	0	0	3	1	2

```
 48  125.9385     0      0      0      0      3      1      3
 49  121.7708     0      0      0      0      3      2      1
 50  119.6853     0      0      0      0      3      2      2
 51  123.7659     0      0      0      0      3      2      3
 52  145.2529     0      0      0      0      3      3      1
 53  141.3716     0      0      0      0      3      3      2
 54  149.1324     0      0      0      0      3      3      3

PUNCHED OUTPUT SPECIFIED

    INSTRUCTOR INPUT , FACTORS INVOLVED

      FACTOR    ACTIVE     TYPE     NO. LEVELS

        1         NO
        2         NO
        3         NO
        4         NO
        5         YES      FIXED        3
        6         YES      FIXED        3
        7         YES      FIXED        3

    STUDENT INPUT , FACTORS USED

      FACTOR     USED      TYPE     NO. LEVELS         LEVELS USED

        1         NO
        2         NO
        3         NO
        4         NO
        5         YES      FIXED        3          1    2    3
        6         YES      FIXED        3          1    2    3
        7         YES      FIXED        3          1    2    3

    OVERALL AVERAGE

        INSTRUCTOR VALUE    125.00
        STUDENT VALUE       125.00

    INSTRUCTOR INPUT
    BLOCKING AND MAIN EFFECTS

      FACTOR    NO. LEVELS    TRT. EFFECTS

        5           3          -3.000    0.000    3.000
        6           3         -10.000   -5.000   15.000
        7           3          -1.000   -2.000    3.000

    INSTRUCTOR INPUT
    TWO WAY INTERACTION EFFECTS

ROWS-FACTOR    5
```

STUDENT NUMBER 3

* EXP. 4C - FIXED THREE WAY -STUDENT IGNORES FACTOR 5 AND USES 2 LEVELS OF 1-2 OBS *

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	113.8334	1	0	0	0	0	1	1
2	114.3351	1	0	0	0	0	1	2
3	125.6038	1	0	0	0	0	1	3
4	122.1341	1	0	0	0	0	2	1
5	120.0350	1	0	0	0	0	2	2
6	124.[illegible]355	1	0	0	0	0	2	3
7	136.3754	1	0	0	0	0	3	1
8	135.8385	1	0	0	0	0	3	2
9	147.0376	1	0	0	0	0	3	3
10	117.3221	1	0	0	0	0	1	1
11	115.4316	1	0	0	0	0	1	2
12	112.9106	1	0	0	0	0	1	3
13	121.9303	1	0	0	0	0	2	1
14	119.6571	1	0	0	0	0	2	2
15	118.4472	1	0	0	0	0	2	3
16	145.2530	1	0	0	0	0	3	1
17	135.2394	1	0	0	0	0	3	2
18	149.3223	1	0	0	0	0	3	3
19	111.1177	2	0	0	0	0	1	1
20	114.0733	2	0	0	0	0	1	2
21	123.7316	2	0	0	0	0	1	3
22	117.1731	2	0	0	0	0	2	1
23	121.3323	2	0	0	0	0	2	2
24	113.1314	2	0	0	0	0	2	3
25	145.1335	2	0	0	0	0	3	1
26	141.8816	2	0	0	0	0	3	2
27	141.7265	2	0	0	0	0	3	3
28	116.7575	2	0	0	0	0	1	1
29	1[illegible]3.8891	2	0	0	0	0	1	2
30	115.3323	2	0	0	0	0	1	3
31	116.9571	2	0	0	0	0	2	1
32	115.9189	2	0	0	0	0	2	2
33	123.5920	2	0	0	0	0	2	3
34	144.9415	2	0	0	0	0	3	1
35	134.6649	2	0	0	0	0	3	2
36	149.1106	2	0	0	0	0	3	3

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	113.8334	1	0	0	0	1	1	1
2	114.3851	1	0	0	0	3	1	2
3	125.6038	1	0	0	0	3	1	3

STUDENT NUMBER 1

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*****************************************************************************
*
* EXP 40. THREE WAY FIXED - STUDENT USES ONLY 2 LEVELS OF EACH FACTOR - 3 OBS. *
*
*****************************************************************************
```

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	[illegible]		0	0	0	1	1	1
2	[illegible]		0	0	0	1	1	3
3	[illegible]		0	0	0	1	3	1
4	[illegible]		0	0	0	1	3	3
5	[illegible]		0	0	0	[illegible]	1	1
6	[illegible]		0	0	0	3	1	3
7	[illegible]		0	0	0	[illegible]	3	1
8	[illegible]		0	0	0	[illegible]	3	3
9	[illegible]		0	0	0	1	1	1
10	[illegible]		0	0	0	1	1	3
11	[illegible]		0	0	0	1	3	1
12	[illegible]		0	0	0	1	3	3
13	[illegible]		0	0	0	[illegible]	1	1
14	[illegible]		0	0	0	[illegible]	1	3
15	[illegible]		0	0	0	[illegible]	3	1
16	[illegible]		0	0	0	[illegible]	3	3
17	[illegible]		0	0	0	1	1	1
18	[illegible]		0	0	0	1	1	3
19	[illegible]		0	0	0	1	3	1
20	[illegible]		0	0	0	1	3	3
21	[illegible]		0	0	0	3	1	1
22	[illegible]		0	0	0	3	1	3
23	[illegible]		0	0	0	[illegible]	3	1
24	145.5703		0	0	0	3	3	3

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	FIXED	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED

FILMED FROM BEST AVAILABLE COPY

STUDENT NUMBER 1

```
**********************************************************************
*                                                                    *
* EXP 4E. THREE-WAY FIXED - STUDENT CALLS FACTOR 5 RANDOM   TWO OBS *
*                                                                    *
**********************************************************************
```

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	[illegible]	0	0	0	0	1	1	1
2	[illegible]	0	0	0	0	1	1	2
3	113.1457	0	0	0	0	1	1	3
4	[illegible]	0	0	0	0	1	2	1
5	[illegible]	0	0	0	0	1	2	2
6	[illegible]	0	0	0	0	1	2	3
7	[illegible]	0	0	0	0	1	3	1
8	[illegible]	0	0	0	0	1	3	2
9	[illegible]	0	0	0	0	1	3	3
10	[illegible]	0	0	0	0	1	1	1
11	[illegible]	0	0	0	0	1	1	2
12	[illegible]	0	0	0	0	1	1	3
13	115.7262	0	0	0	0	1	2	1
14	[illegible]	0	0	0	0	1	2	2
15	[illegible]	0	0	0	0	1	2	3
16	[illegible]	0	0	0	0	1	3	1
17	[illegible]	0	0	0	0	1	3	2
18	[illegible]	0	0	0	0	2	3	3
19	[illegible]	0	0	0	0	2	1	1
20	[illegible]	0	0	0	0	2	1	2
21	[illegible]	0	0	0	0	2	1	3
22	[illegible]	0	0	0	0	2	2	1
23	[illegible]	0	0	0	0	2	2	2
24	[illegible]	0	0	0	0	2	2	3
25	[illegible]	0	0	0	0	2	3	1
26	[illegible]	0	0	0	0	2	3	2
27	[illegible]	0	0	0	0	2	3	3
28	[illegible]	0	0	0	0	2	1	1
29	[illegible]	0	0	0	0	2	1	2
30	[illegible]	0	0	0	0	2	1	3
31	[illegible]	0	0	0	0	2	2	1
32	[illegible]	0	0	0	0	2	2	2
33	[illegible]	0	0	0	0	2	2	3
34	[illegible]	0	0	0	0	2	3	1
35	134.7321	0	0	0	0	2	3	2
36	[illegible]	0	0	0	0	3	3	3
37	[illegible]	0	0	0	0	3	1	1
38	[illegible]	0	0	0	0	3	1	2
39	125.7465	0	0	0	0	3	1	3
40	[illegible]	0	0	0	0	3	2	1
41	[illegible]	0	0	0	0	3	2	2
42	123.6191	0	0	0	0	3	2	3
43	144.9785	0	0	0	0	3	3	1
44	[illegible]	0	0	0	0	3	3	2
45	[illegible]	0	0	0	0	3	3	3
46	[illegible]	0	0	0	0	3	1	1
47	113.7324	0	0	0	0	3	1	2

48	126.1751	0	0	0	0	3	1	3
49	121.5037	0	0	0	0	3	2	1
50	120.1101	0	0	0	0	3	2	2
51	123.8302	0	0	0	0	3	2	3
52	144.7761	0	0	0	0	3	3	1
53	143.9657	0	0	0	0	3	3	2
54	149.0249	0	0	0	0	3	3	3

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	FIXED	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED		
1	NO					
2	NO					
3	NO					
4	NO					
5	YES	RANDOM	3	1	2	3
6	YES	FIXED	3	1	2	3
7	YES	FIXED	3	1	2	3

OVERALL AVERAGE

INSTRUCTOR VALUE 125.00
STUDENT VALUE 125.00

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

FACTOR	NO. LEVELS	TRT. EFFECTS		
5	3	-3.000	0.000	3.000
6	3	-10.000	-5.000	15.000
7	3	-1.000	-2.000	3.000

INSTRUCTOR INPUT
TWO WAY INTERACTION EFFECTS

ROWS-FACTOR 5

STUDENT NUMBER 2

+ EXP 4F - FIXED THREE WAY - STUDENT CALLS FACTOR : RANDOM- ONE OBS. PER CELL +

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	113.2727	0	0	0	0	1	2	3
2	131.9114	0	0	0	0	1	3	1
3	134.8718	0	0	0	0	1	3	2
4	119.74[illegible]	0	0	0	0	3	2	2
5	147.1638	0	0	0	0	1	3	3
6	143.3145	0	0	0	0	3	3	3
7	115.9768	0	0	0	0	2	1	1
8	126.0215	0	0	0	0	3	1	3
9	122.3719	0	0	0	0	3	2	1
10	115.1613	0	0	0	0	2	2	3
11	124.1783	0	0	0	0	3	2	3
12	137.1642	0	0	0	0	2	3	1
13	116.7397	0	0	0	0	1	2	1
14	115.6658	0	0	0	0	2	1	2
15	113.4267	0	0	0	0	1	1	3
16	123.2613	0	0	0	0	2	1	3
17	144.7843	0	0	0	0	3	3	1
18	134.6335	0	0	0	0	2	3	2
19	131.7764	0	0	0	0	2	3	3
20	147.6591	0	0	0	0	3	3	2
21	123.9885	0	0	0	0	2	2	1
22	11[illegible].7703	0	0	0	0	3	1	1
23	113.6183	0	0	0	0	3	1	2
24	110.7659	0	0	0	0	1	1	1
25	121.2520	0	0	0	0	2	2	2
26	179.3720	0	0	0	0	1	1	2
27	116.1104	0	0	0	0	1	2	2

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	FIXED	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

STUDENT NUMBER 1

```
******************************************************************************
*                                                                            *
* EXP 5A -TWO WAY RANDOM - STUDENT MATCHES INSTRUCTOR - ONE OBS. PER CELL    *
*                                                                            *
******************************************************************************
```

		FACTOR LEVELS						
OBSERVATION		1	2	3	4	5	6	7
1	[illegible]	0	0	[illegible]	0	1	0	[illegible]
2	[illegible]	0	0	[illegible]	0	1	0	[illegible]
3	[illegible]	0	0	[illegible]	0	1	0	[illegible]
4	[illegible]	0	0	[illegible]	0	1	0	[illegible]
5	[illegible]	0	0	[illegible]	0	2	0	[illegible]
6	[illegible]	0	0	[illegible]	0	2	0	[illegible]
7	24.9164	0	0	[illegible]	0	2	0	[illegible]
8	[illegible]	0	0	[illegible]	0	2	0	[illegible]
9	[illegible]	0	0	[illegible]	0	3	0	[illegible]
10	[illegible]	0	0	[illegible]	0	3	0	[illegible]
11	[illegible]	0	0	[illegible]	0	3	0	[illegible]
12	[illegible]	0	0	[illegible]	0	3	0	[illegible]
13	[illegible]	0	0	[illegible]	0	4	0	[illegible]
14	19.722[illegible]	0	0	[illegible]	0	4	0	[illegible]
15	[illegible]	0	0	[illegible]	0	4	0	[illegible]
16	17.7527	0	0	[illegible]	0	4	0	[illegible]
17	[illegible]	0	0	[illegible]	0	5	0	[illegible]
18	[illegible]	0	0	[illegible]	0	5	0	[illegible]
19	[illegible]	0	0	[illegible]	0	5	0	[illegible]
20	13.5903	0	0	[illegible]	0	5	0	[illegible]

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	RANDOM	5
6	NO		
7	YES	RANDOM	4

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED

STUDENT NUMBER 2

****
* EXP. 58 - TWO WAY RANDOM - STUDENT MATCHES INSTRUCTOR - TWO OBS. PER CELL *
****

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	[illegible]	0	0	0	0	4	0	4
2	[illegible]	0	0	0	0	1	0	2
3	24.6134	0	0	0	0	2	0	1
4	20.9175	0	0	0	0	4	0	2
5	15.1526	0	0	0	0	4	0	1
6	24.6377	0	0	0	0	2	0	1
7	22.6130	0	0	0	0	5	0	2
8	18.1561	0	0	0	0	3	0	2
9	18.1418	0	0	0	0	4	0	1
10	[illegible]	0	0	0	0	3	0	2
11	21.7155	0	0	0	0	5	0	4
12	[illegible]	0	0	0	0	5	0	1
13	15.2666	0	0	0	0	4	0	3
14	22.2307	0	0	0	0	1	0	1
15	22.3359	0	0	0	0	5	0	2
16	22.7178	0	0	0	0	1	0	4
17	19.1711	0	0	0	0	3	0	1
18	20.5872	0	0	0	0	2	0	4
19	22.3191	0	0	0	0	5	0	3
20	15.1696	0	0	0	0	3	0	1
21	20.2572	0	0	0	0	1	0	2
22	18.2845	0	0	0	0	4	0	3
23	19.3140	0	0	0	0	3	0	3
24	20.2109	0	0	0	0	1	0	3
25	20.6334	0	0	0	0	2	0	[illegible]
26	18.3703	0	0	0	0	3	0	4
27	22.3157	0	0	0	0	5	0	1
28	18.3551	0	0	0	0	3	0	4
29	22.2122	0	0	0	0	1	0	1
30	[illegible]	0	0	0	0	2	0	2
31	22.8210	0	0	0	0	5	0	3
32	21.1356	0	0	0	0	2	0	3
33	21.6794	0	0	0	0	2	0	4
34	19.3963	0	0	0	0	4	0	4
35	19.3363	0	0	0	0	3	0	3
36	20.9334	0	0	0	0	4	0	2
37	22.6285	0	0	0	0	1	0	4
38	21.6969	0	0	0	0	5	0	4
39	21.1516	0	0	0	0	2	0	3
40	19.2066	0	0	0	0	1	0	3

PUNCHED OUTPUT SPECIFIED

STUDENT NUMBER 3

```
****************************************************************
*                                                              *
* EXP. 5C - TWO-WAY RANDOM - STOT. USES FACTORS 1 AND 3 RATHER THAN 5 AND 7 *
*                                                              *
****************************************************************
```

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	18.3596	1	0	1	0	0	0	0
2	23.1315	1	0	2	0	0	0	0
3	25.5325	1	0	3	0	0	0	0
4	23.4511	1	0	4	0	0	0	0
5	26.1549	2	0	1	0	0	0	0
6	26.1659	2	0	2	0	0	0	0
7	23.1461	2	0	3	0	0	0	0
8	22.4250	2	0	4	0	0	0	0
9	21.2519	3	0	1	0	0	0	0
10	23.4943	3	0	2	0	0	0	0
11	20.4467	3	0	3	0	0	0	0
12	23.7415	3	0	4	0	0	0	0
13	25.5128	4	0	1	0	0	0	0
14	23.0547	4	0	2	0	0	0	0
15	23.7374	4	0	3	0	0	0	0
16	25.5305	4	0	4	0	0	0	0
17	19.1478	5	0	1	0	0	0	0
18	26.1364	5	0	2	0	0	0	0
19	26.1412	5	0	3	0	0	0	0
20	24.5027	5	0	4	0	0	0	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

		FACTOR LEVELS						
	OBSERVATION	1	2	3	4	5	6	7
1	18.3596	1	0	1	0	1	0	3
2	23.1315	1	0	2	0	4	0	1
3	25.5325	1	0	3	0	5	0	3
4	23.4511	1	0	4	0	4	0	3
5	26.1549	2	0	1	0	5	0	4
6	26.1659	2	0	2	0	5	0	4
7	23.1461	2	0	3	0	4	0	1
8	22.4250	2	0	4	0	2	0	3
9	21.2519	3	0	1	0	1	0	1
10	23.4943	3	0	2	0	4	0	3
11	20.4467	3	0	3	0	3	0	1
12	23.7415	3	0	4	0	2	0	1
13	25.5128	4	0	1	0	5	0	3
14	23.0547	4	0	2	0	4	0	4
15	23.7374	4	0	3	0	2	0	1
16	25.5305	4	0	4	0	5	0	3
17	19.1478	5	0	1	0	1	0	4
18	26.1364	5	0	2	0	5	0	4
19	26.1412	5	0	3	0	5	0	4

STUDENT NUMBER

* EXP. 5C - TWO WAY RANDOM - STDT. CALLS FACTOR 5 FIXED - 3 LEVELS EACH, 2 OBS. *

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	21.5951	0	0	0	0	1	0	1
2	21.5790	0	0	0	0	1	0	1
3	24.3176	0	0	0	0	1	0	2
4	24.2869	0	0	0	0	1	0	2
5	23.7171	0	0	0	0	1	0	3
6	23.7128	0	0	0	0	1	0	3
7	21.7311	0	0	0	0	3	0	1
8	21.8835	0	0	0	0	3	0	1
9	21.6502	0	0	0	0	3	0	2
10	21.3480	0	0	0	0	3	0	2
11	18.7549	0	0	0	0	3	0	3
12	18.7236	0	0	0	0	3	0	3
13	17.8456	0	0	0	0	5	0	1
14	17.6456	0	0	0	0	5	0	1
15	17.4713	0	0	0	0	5	0	2
16	17.3153	0	0	0	0	5	0	2
17	20.6597	0	0	0	0	5	0	3
18	[illegible]	0	0	0	0	5	0	3

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	RANDOM	5
6	NO		
7	YES	RANDOM	4

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED
1	NO			
2	NO			
3	NO			
4	NO			
5	YES	FIXED	3	1 3 5
6	NO			

STUDENT NUMBER 5

EXP. 5E- RANDOM TWC WAY - STD. IGNORES FACTOR 7 AND USES 4 LEVELS OF 5, 4 OBS.

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	[illegible]	0	0	0	0	1	0	0
2	[illegible]	0	0	0	0	2	0	0
3	[illegible]	0	0	0	0	3	0	0
4	[illegible]	0	0	0	0	4	0	0
5	[illegible]	0	0	0	0	1	0	0
6	[illegible]	0	0	0	0	2	0	0
7	[illegible]	0	0	0	0	3	0	0
8	[illegible]	0	0	0	0	4	0	0
9	[illegible]	0	0	0	0	1	0	0
10	[illegible]	0	0	0	0	2	0	0
11	[illegible]	0	0	0	0	3	0	0
12	[illegible]	0	0	0	0	4	0	0
13	[illegible]	0	0	0	0	1	0	0
14	[illegible]	0	0	0	0	2	0	0
15	[illegible]	0	0	0	0	3	0	0
16	[illegible]	0	0	0	0	4	0	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	20.7533	0	0	0	0	1	0	1
2	20.3595	0	0	0	0	2	0	4
3	21.7353	0	0	0	0	3	0	2
4	20.5433	0	0	0	0	4	0	3
5	21.7761	0	0	0	0	1	0	2
6	20.9505	0	0	0	0	2	0	4
7	21.7553	0	0	0	0	3	0	2
8	16.9943	0	0	0	0	4	0	1
9	21.8012	0	0	0	0	1	0	2
10	22.1055	0	0	0	0	2	0	3
11	22.7590	0	0	0	0	3	0	3
12	20.5318	0	0	0	0	4	0	3
13	21.7325	0	0	0	0	1	0	2
14	18.6014	0	0	0	0	2	0	1
15	22.7726	0	0	0	0	3	0	3
16	19.2890	0	0	0	0	4	0	2

INSTRUCTOR INPUT , FACTORS INVOLVED

STUDENT NUMBER 1

++
+ EXP 6A - MIXED THREE WAY STDT MATCHES INST. MODEL - 2 OBSERVATIONS +
++

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	96.4293	0	0	0	0	1	1	1
2	93.4322	0	0	0	0	1	1	2
3	103.4305	0	0	0	0	1	1	3
4	95.9434	0	0	0	0	1	2	1
5	97.0443	0	0	0	0	1	2	2
6	[illegible]	0	0	0	0	1	2	3
7	94.8739	0	0	0	0	1	3	1
8	[illegible]	0	0	0	0	1	3	2
9	101.8756	0	0	0	0	1	3	3
10	93.4294	0	0	0	0	1	1	1
11	95.4305	0	0	0	0	1	1	2
12	103.4292	0	0	0	0	1	1	3
13	[illegible]	0	0	0	0	1	2	1
14	[illegible]	0	0	0	0	1	2	2
15	[illegible]	0	0	0	0	1	2	3
16	[illegible]	0	0	0	0	1	3	1
17	96.8755	0	0	0	0	1	3	2
18	[illegible]	0	0	0	0	1	3	3
19	[illegible]	0	0	0	0	2	1	1
20	[illegible]	0	0	0	0	2	1	2
21	[illegible]	0	0	0	0	2	1	3
22	[illegible]	0	0	0	0	2	2	1
23	[illegible]	0	0	0	0	2	2	2
24	[illegible]	0	0	0	0	2	2	3
25	96.4225	0	0	0	0	2	3	1
26	[illegible]	0	0	0	0	2	3	2
27	102.4227	0	0	0	0	2	3	3
28	[illegible]	0	0	0	0	2	1	1
29	[illegible]	0	0	0	0	2	1	2
30	[illegible]	0	0	0	0	2	1	3
31	99.2866	0	0	0	0	2	2	1
32	101.2869	0	0	0	0	2	2	2
33	103.2861	0	0	0	0	2	2	3
34	96.4226	0	0	0	0	2	3	1
35	100.4215	0	0	0	0	2	3	2
36	[illegible]	0	0	0	0	2	3	3
37	[illegible]	0	0	0	0	3	1	1
38	[illegible]	0	0	0	0	3	1	2
39	102.0478	0	0	0	0	3	1	3
40	106.0456	0	0	0	0	3	2	1
41	105.0472	0	0	0	0	3	2	2
42	101.0455	0	0	0	0	3	2	3
43	106.2075	0	0	0	0	3	3	1
44	[illegible]	0	0	0	0	3	3	2
45	101.2074	0	0	0	0	3	3	3
46	107.0471	0	0	0	0	3	1	1
47	106.0476	0	0	0	0	3	1	2

48	102.0495	0	0	0	0	3	1	3
49	106.0450	0	0	0	0	3	2	1
50	105.0475	0	0	0	0	3	2	2
51	101.0463	0	0	0	0	3	2	3
52	106.2067	0	0	0	0	3	3	1
53	105.2074	0	0	0	0	3	3	2
54	101.2077	0	0	0	0	3	3	3

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	RANDOM	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED		
1	NO					
2	NO					
3	NO					
4	NO					
5	YES	FIXED	3	1	2	3
6	YES	RANDOM	3	1	2	3
7	YES	FIXED	3	1	2	3

OVERALL AVERAGE

INSTRUCTOR VALUE	100.00
STUDENT VALUE	100.00

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

FACTOR	NO. LEVELS	TRT. EFFECTS		
5	3	-3.000	0.000	3.000
6	3	2.364	1.012	-.035
7	3	-1.000	0.000	1.000

INSTRUCTOR INPUT
TWO WAY INTERACTION EFFECTS

ROWS-FACTOR 5

STUDENT NUMBER 2

EXP. 6E - MIXED THREE WAY WHICH STUDENT CALLS FIXED - TWO OBSERVATIONS

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	94.0017	0	0	0	0	1	1	1
2	[illegible]	0	0	0	0	1	1	2
3	101.3001	0	0	0	0	1	1	3
4	94.1142	0	0	0	0	1	2	1
5	96.3395	0	0	0	0	1	2	2
6	101.1183	0	0	0	0	1	2	3
7	95.1220	0	0	0	0	1	3	1
8	97.1124	0	0	0	0	1	3	2
9	[illegible]	0	0	0	0	1	3	3
10	94.0013	0	0	0	0	1	1	1
11	96.0013	0	0	0	0	1	1	2
12	101.0014	0	0	0	0	1	1	3
13	94.3342	0	0	0	0	1	2	1
14	96.6335	0	0	0	0	1	2	2
15	[illegible]	0	0	0	0	1	2	3
16	[illegible]	0	0	0	0	1	3	1
17	[illegible]	0	0	0	0	1	3	2
18	[illegible]	0	0	0	0	1	3	3
19	96.6724	0	0	0	0	2	1	1
20	[illegible]	0	0	0	0	2	1	2
21	[illegible]	0	0	0	0	2	1	3
22	[illegible]	0	0	0	0	2	2	1
23	[illegible]	0	0	0	0	2	2	2
24	[illegible]	0	0	0	0	2	2	3
25	[illegible]	0	0	0	0	2	3	1
26	95.9077	0	0	0	0	2	3	2
27	[illegible]	0	0	0	0	2	3	3
28	98.3728	0	0	0	0	2	1	1
29	98.0736	0	0	0	0	2	1	2
30	[illegible]	0	0	0	0	2	1	3
31	[illegible]	0	0	0	0	2	2	1
32	100.3749	0	0	0	0	2	2	2
33	102.3561	0	0	0	0	2	2	3
34	97.9327	0	0	0	0	2	3	1
35	99.9386	0	0	0	0	2	3	2
36	101.9286	0	0	0	0	2	3	3
37	105.2914	0	0	0	0	3	1	1
38	[illegible]	0	0	0	0	3	1	2
39	100.2909	0	0	0	0	3	1	3
40	105.3243	0	0	0	0	3	2	1
41	104.3233	0	0	0	0	3	2	2
42	100.3233	0	0	0	0	3	2	3
43	104.9452	0	0	0	0	3	3	1
44	103.9453	0	0	0	0	3	3	2
45	[illegible]	0	0	0	0	3	3	3
46	105.2916	0	0	0	0	3	1	1
47	104.2916	0	0	0	0	3	1	2

48	100.2982	0	0	0	0	3	1	3
49	105.3254	0	0	0	0	3	2	1
50	104.3259	0	0	0	0	3	2	2
51	100.3354	0	0	0	0	3	2	3
52	104.9447	0	0	0	0	3	3	1
53	103.9444	0	0	0	0	3	3	2
54	99.9430	0	0	0	0	3	3	3

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	NO		
2	NO		
3	NO		
4	NO		
5	YES	FIXED	3
6	YES	RANDOM	3
7	YES	FIXED	3

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED		
1	NO					
2	NO					
3	NO					
4	NO					
5	YES	FIXED	3	1	2	3
6	YES	FIXED	3	1	2	3
7	YES	FIXED	3	1	2	3

OVERALL AVERAGE

INSTRUCTOR VALUE 100.00
STUDENT VALUE 100.00

INSTRUCTOR INPUT
BLOCKING AND MAIN EFFECTS

FACTOR	NO. LEVELS	TRT. EFFECTS		
5	3	-3.000	0.000	3.000
6	3	-.090	.093	.261
7	3	-1.000	0.000	1.000

INSTRUCTOR INPUT
TWO WAY INTERACTION EFFECTS

ROWS-FACTOR 5

STUDENT NUMBER 1

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* EXP. 7A - STUDENT IGNORES BLOCKING (8 OBSERVATIONS) *

****

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	75.2555	0	0	0	0	1	1	0
2	75.7316	0	0	0	0	1	2	0
3	74.1[illegible]3	0	0	0	0	1	3	0
4	77.3228	0	0	0	0	2	1	0
5	77.4264	0	0	0	0	2	2	0
6	77.7756	0	0	0	0	2	3	0
7	65.1249	0	0	0	0	3	1	0
8	61.6226	0	0	0	0	3	2	0
9	73.2266	0	0	0	0	3	3	0
10	76.5204	0	0	0	0	1	1	0
11	75.3716	0	0	0	0	1	2	0
12	69.8555	0	0	0	0	1	3	0
13	[illegible]	0	0	0	0	2	1	0
14	75.3375	0	0	0	0	2	2	0
15	65.3113	0	0	0	0	2	3	0
16	57.1049	0	0	0	0	3	1	0
17	[illegible]	0	0	0	0	3	2	0
18	[illegible]	0	0	0	0	3	3	0
19	[illegible]	0	0	0	0	1	1	0
20	[illegible]	0	0	0	0	1	2	0
21	72.[illegible]	0	0	0	0	1	3	0
22	61.8899	0	0	0	0	2	1	0
23	75.1351	0	0	0	0	2	2	0
24	[illegible]	0	0	0	0	2	3	0
25	[illegible]	0	0	0	0	3	1	0
26	[illegible]	0	0	0	0	3	2	0
27	[illegible]	0	0	0	0	3	3	0
28	65.4075	0	0	0	0	1	1	0
29	80.4593	0	0	0	0	1	2	0
30	74.7852	0	0	0	0	1	3	0
31	60.1056	0	0	0	0	2	1	0
32	77.1023	0	0	0	0	2	2	0
33	71.6665	0	0	0	0	2	3	0
34	62.1536	0	0	0	0	3	1	0
35	61.4115	0	0	0	0	3	2	0
36	74.5383	0	0	0	0	3	3	0
37	72.3893	0	0	0	0	1	1	0
38	77.7356	0	0	0	0	1	2	0
39	72.7415	0	0	0	0	1	3	0
40	76.4237	0	0	0	0	2	1	0
41	76.[illegible]	0	0	0	0	2	2	0
42	73.4336	0	0	0	0	2	3	0
43	65.3631	0	0	0	0	3	1	0
44	62.9087	0	0	0	0	3	2	0
45	71.6563	0	0	0	0	3	3	0
46	72.5896	0	0	0	0	1	1	0
47	71.2342	0	0	0	0	1	2	0

48	76.0020	0	0	0	0	1	3	0
49	78.8040	0	0	0	0	2	1	0
50	77.6042	0	0	0	0	2	2	0
51	69.8308	0	0	0	0	2	3	0
52	86.2213	0	0	0	0	3	1	0
53	80.1725	0	0	0	0	3	2	0
54	77.4520	0	0	0	0	3	3	0
55	71.2771	0	0	0	0	1	1	0
56	72.4627	0	0	0	0	1	2	0
57	73.7766	0	0	0	0	1	3	0
58	73.4386	0	0	0	0	2	1	0
59	73.3747	0	0	0	0	2	2	0
60	69.5467	0	0	0	0	2	3	0
61	85.3258	0	0	0	0	3	1	0
62	82.4825	0	0	0	0	3	2	0
63	69.0607	0	0	0	0	3	3	0
64	73.7547	0	0	0	0	1	1	0
65	73.0794	0	0	0	0	1	2	0
66	74.6309	0	0	0	0	1	3	0
67	73.7233	0	0	0	0	2	1	0
68	76.7327	0	0	0	0	2	2	0
69	73.3233	0	0	0	0	2	3	0
70	86.2029	0	0	0	0	3	1	0
71	81.0067	0	0	0	0	3	2	0
72	70.9421	0	0	0	0	3	3	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

		FACTOR LEVELS						
OBSERVATION		1	2	3	4	5	6	7
1	75.8395	1	4	5	0	1	1	0
2	75.7956	7	1	6	0	1	2	0
3	74.1463	10	4	8	0	1	3	0
4	77.9226	8	4	8	0	2	1	0
5	77.4284	10	10	10	0	2	2	0
6	77.7756	10	3	9	0	2	3	0
7	85.1849	7	5	1	0	3	1	0
8	81.6826	3	8	5	0	3	2	0
9	72.0396	1	5	3	0	3	3	0
10	76.9230	7	3	6	0	1	1	0
11	75.3796	5	3	8	0	1	2	0
12	69.8555	3	7	3	0	1	3	0
13	80.1408	10	4	7	0	2	1	0
14	76.8678	8	10	3	0	2	2	0
15	68.3185	3	1	4	0	2	3	0
16	87.1049	10	2	2	0	3	1	0
17	81.1106	2	7	5	0	3	2	0
18	73.3657	10	5	1	0	3	3	0
19	69.0173	9	1	4	0	1	1	0
20	74.8741	8	5	7	0	1	2	0
21	72.3865	7	3	5	0	1	3	0
22	81.8299	2	3	6	0	2	1	0
23	75.6351	6	3	4	0	2	2	0
24	75.5796	7	8	2	0	2	3	0
25	82.8433	8	10	5	0	3	1	0
26	85.4594	10	4	[illegible]	0	3	2	0
27	73.2815	3	2	[illegible]	0	3	3	0
28	[illegible]	6	[illegible]	4	[illegible]	[illegible]	[illegible]	0

STUDENT NUMBER 2

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* EXP. 7E - STUDENT CONSIDERS ONLY BLOCKING FACTOR 1 (4 OBS.) *
****

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	72.5420	1	0	0	0	1	1	0
2	70.6857	1	0	0	0	1	2	0
3	69.3132	1	0	0	0	1	3	0
4	70.3461	1	0	0	0	2	1	0
5	75.3494	1	0	0	0	2	2	0
6	71.6927	1	0	0	0	2	3	0
7	65.3956	1	0	0	0	3	1	0
8	78.2253	1	0	0	0	3	2	0
9	71.[illegible]	1	0	0	0	3	3	0
10	73.3236	1	0	0	0	1	1	0
11	71.1222	1	0	0	0	1	2	0
12	[illegible].3097	1	0	0	0	1	3	0
13	73.[illegible]	1	0	0	0	2	1	0
14	74.[illegible]	1	0	0	0	2	2	0
15	69.6019	1	0	0	0	2	3	0
16	[illegible]	1	0	0	0	3	1	0
17	79.[illegible]	1	0	0	0	3	2	0
18	67.7[illegible]	1	0	0	0	3	3	0
19	[illegible]	1	0	0	0	1	1	0
20	73.[illegible]	1	0	0	0	1	2	0
21	67.[illegible]	1	0	0	0	1	3	0
22	74.[illegible]	1	0	0	0	2	1	0
23	76.4007	1	0	0	0	2	2	0
24	69.7555	1	0	0	0	2	3	0
25	79.[illegible]	1	0	0	0	3	1	0
26	77.[illegible]	1	0	0	0	3	2	0
27	[illegible]	1	0	0	0	3	3	0
28	68.[illegible]	1	0	0	0	1	1	0
29	73.7721	1	0	0	0	1	2	0
30	67.[illegible]	1	0	0	0	1	3	0
31	70.3522	1	0	0	0	2	1	0
32	76.2019	1	0	0	0	2	2	0
33	71.9453	1	0	0	0	2	3	0
34	79.[illegible]	1	0	0	0	3	1	0
35	79.2601	1	0	0	0	3	2	0
36	66.4918	1	0	0	0	3	3	0
37	69.9703	2	0	0	0	1	1	0
38	69.3863	2	0	0	0	1	2	0
39	66.2157	2	0	0	0	1	3	0
40	72.7767	2	0	0	0	2	1	0
41	74.2133	2	0	0	0	2	2	0
42	71.0704	2	0	0	0	2	3	0
43	60.9730	2	0	0	0	3	1	0
44	77.4927	2	0	0	0	3	2	0
45	64.3024	2	0	0	0	3	3	0
46	73.1499	2	0	0	0	1	1	0
47	70.4508	2	0	0	0	1	2	0

48	65.2420	2	0	0	0	1	3	0
49	74.6148	2	0	0	0	2	1	0
50	73.5297	2	0	0	0	2	2	0
51	66.6285	2	0	0	0	2	3	0
52	62.4936	2	0	0	0	3	1	0
53	70.1317	2	0	0	0	3	2	0
54	65.9681	2	0	0	0	3	3	0
55	70.1106	2	0	0	0	1	1	0
56	70.1997	2	0	0	0	1	2	0
57	67.2935	2	0	0	0	1	3	0
58	77.1347	2	0	0	0	2	1	0
59	74.1396	2	0	0	0	2	2	0
60	67.336[illegible]	2	0	0	0	2	3	0
61	63.4139	2	0	0	0	3	1	0
62	79.4562	2	0	0	0	3	2	0
63	69.3464	2	0	0	0	3	3	0
64	80.3158	2	0	0	0	1	1	0
65	67.2541	2	0	0	0	1	2	0
66	79.7540	2	0	0	0	1	3	0
67	[illegible]	2	[illegible]	0	0	2	1	0
68	73.5742	2	0	0	0	2	2	0
69	67.[illegible]44	2	0	0	0	2	3	0
70	63.1934	2	0	0	0	3	1	0
71	62.4325	2	0	0	0	3	2	0
72	63.[illegible]02	2	0	0	0	3	3	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

OBSERVATION		FACTOR LEVELS 1	2	3	4	5	6	7
1	72.[illegible]	1	5	8	0	1	1	0
2	73.6757	1	10	2	0	1	2	0
3	60.[illegible]32	1	1	1	0	1	3	0
4	70.3461	1	2	7	0	2	1	0
5	75.3494	1	7	1	0	2	2	0
6	71.6927	1	8	1	0	2	3	0
7	35.3956	1	8	10	0	3	1	0
8	78.5253	1	2	8	0	3	2	0
9	71.9310	1	8	8	0	3	3	0
10	73.3236	1	3	10	0	1	1	0
11	71.5222	1	1	6	0	1	2	0
12	73.3697	1	8	10	0	1	3	0
13	73.5605	1	1	9	0	2	1	0
14	74.2299	1	1	3	0	2	2	0
15	69.6819	1	10	2	0	2	3	0
16	64.2612	1	4	8	0	3	1	0
17	79.5751	1	3	3	0	3	2	0
18	67.7062	1	2	4	0	3	3	0
19	72.2340	1	5	4	0	1	1	0
20	73.6190	1	4	2	0	1	2	0
21	67.0129	1	10	3	0	1	3	0
22	74.6087	1	7	9	0	2	1	0
23	76.4007	1	9	2	0	2	2	0
24	69.7695	1	9	3	0	2	3	0
25	79.0424	1	6	3	0	3	1	0
26	77.8856	1	2	2	0	3	2	0
27	69.9576	1	8	9	0	3	3	0
28	68.5874	1	2	6	0	[illegible]	[illegible]	0

STUDENT NUMBER 3

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*
* EXP. 7C - STUDENT CONSIDERS BLOCKING FACTORS 1 AND 2 (2 DES.) *
*
****

FACTOR LEVELS

	OBSERVATION	1	2	3	4	5	6	7
1	70.1126	1	1	0	0	1	1	0
2	66.1529	1	1	0	0	1	2	0
3	67.2240	1	1	0	0	1	3	0
4	72.3532	1	1	0	0	2	1	0
5	73.1583	1	1	0	0	2	2	0
6	65.1264	1	1	0	0	2	3	0
7	62.0461	1	1	0	0	3	1	0
8	76.1685	1	1	0	0	3	2	0
9	65.0047	1	1	0	0	3	3	0
10	60.3146	1	1	0	0	1	1	0
11	70.9519	1	1	0	0	1	2	0
12	69.5042	1	1	0	0	1	3	0
13	72.3302	1	1	0	0	2	1	0
14	70.0452	1	1	0	0	2	2	0
15	67.1318	1	1	0	0	2	3	0
16	73.0437	1	1	0	0	3	1	0
17	74.0427	1	1	0	0	3	2	0
18	[illegible]	1	1	0	0	3	3	0
19	71.3513	1	2	0	0	1	1	0
20	71.4216	1	2	0	0	1	2	0
21	63.1116	1	2	0	0	1	3	0
22	71.9953	1	2	0	0	2	1	0
23	75.4376	1	2	0	0	2	2	0
24	67.5165	1	2	0	0	2	3	0
25	82.5316	1	2	0	0	3	1	0
26	73.4339	1	2	0	0	3	2	0
27	63.4442	1	2	0	0	3	3	0
28	70.4451	1	2	0	0	1	1	0
29	71.3547	1	2	0	0	1	2	0
30	70.9314	1	2	0	0	1	3	0
31	73.1311	1	2	0	0	2	1	0
32	74.1437	1	2	0	0	2	2	0
33	71.3657	1	2	0	0	2	3	0
34	82.3833	1	2	0	0	3	1	0
35	75.9086	1	2	0	0	3	2	0
36	65.5329	1	2	0	0	3	3	0
37	63.7354	2	1	0	0	1	1	0
38	66.2352	2	1	0	0	1	2	0
39	64.9241	2	1	0	0	1	3	0
40	72.3151	2	1	0	0	2	1	0
41	71.5110	2	1	0	0	2	2	0
42	68.3731	2	1	0	0	2	3	0
43	83.3318	2	1	0	0	3	1	0
44	75.3265	2	1	0	0	3	2	0
45	67.3325	2	1	0	0	3	3	0
46	63.3738	2	1	0	0	1	1	0
47	65.8555	2	1	0	0	1	2	0

48	68.3342	2	1	0	0	1	3	0
49	73.3407	2	1	0	0	2	1	0
50	72.0854	2	1	0	0	2	2	0
51	65.9193	2	1	0	0	2	3	0
52	76.9286	2	1	0	0	3	1	0
53	75.7921	2	1	0	0	3	2	0
54	63.6322	2	1	0	0	3	3	0
55	66.7633	2	2	0	0	1	1	0
56	70.6984	2	2	0	0	1	2	0
57	65.3171	2	2	0	0	1	3	0
58	74.6336	2	2	0	0	2	1	0
59	74.7015	2	2	0	0	2	2	0
60	69.2144	2	2	0	0	2	3	0
61	61.6334	2	2	0	0	3	1	0
62	76.2010	2	2	0	0	3	2	0
63	67.1943	2	2	0	0	3	3	0
64	70.1530	2	2	0	0	1	1	0
65	70.2226	2	2	0	0	1	2	0
66	69.1572	2	2	0	0	1	3	0
67	73.7213	2	2	0	0	2	1	0
68	72.[illegible]	2	2	0	0	2	2	0
69	66.6026	2	2	0	0	2	3	0
70	[illegible]	2	2	0	0	3	1	0
71	70.9254	2	2	0	0	3	2	0
72	66.1678	2	2	0	0	3	3	0

PUNCHED OUTPUT SPECIFIED

FACTORS USED BY MODEL IF DIFFERENT

	OBSERVATION	FACTOR LEVELS 1	2	3	4	5	6	7
1	70.2126	1	1	3	0	1	1	0
2	68.1523	1	1	10	0	1	2	0
3	67.3340	1	1	6	0	1	3	0
4	72.0292	1	1	2	0	2	1	0
5	73.0363	1	1	2	0	2	2	0
6	65.0234	1	1	8	0	2	3	0
7	82.0461	1	1	9	0	3	1	0
8	76.1665	1	1	10	0	3	2	0
9	66.3047	1	1	6	0	3	3	0
10	63.3148	1	1	6	0	1	1	0
11	70.5519	1	1	5	0	1	2	0
12	63.5842	1	1	1	0	1	3	0
13	72.0362	1	1	2	0	2	1	0
14	70.0452	1	1	8	0	2	2	0
15	67.1626	1	1	10	0	2	3	0
16	79.0437	1	1	2	0	3	1	0
17	74.0427	1	1	8	0	3	2	0
18	68.5950	1	1	1	0	3	3	0
19	71.3985	1	2	1	0	1	1	0
20	71.4260	1	2	4	0	1	2	0
21	69.9616	1	2	3	0	1	3	0
22	71.9983	1	2	10	0	2	1	0
23	75.4378	1	2	4	0	2	2	0
24	67.9085	1	2	7	0	2	3	0
25	82.8886	1	2	9	0	3	1	0
26	79.4539	1	2	4	0	3	2	0
27	68.9482	1	2	3	0	3	3	0
28	70.4451	1	2	4	0	[illegible]	[illegible]	0

STUDENT NUMBER 4

****
*
* EXP. 7C - STUDENT CONSIDERS ALL THREE BLOCKING FACTORS (1 OBS.) *
*
****

FACTOR LEVELS

	OBSERVATION	1	2	3	4	5	6	7
1	73.5859	1	1	1	0	1	1	0
2	74.5[illegible]	1	1	1	0	1	2	0
3	72.5164	1	1	1	0	1	3	0
4	77.5315	1	1	1	0	2	1	0
5	76.5216	1	1	1	0	2	2	0
6	73.5127	1	1	1	0	2	3	0
7	64.5384	1	1	1	0	3	1	0
8	82.5210	1	1	1	0	3	2	0
9	71.5076	1	1	1	0	3	3	0
10	69.9759	1	1	2	0	1	1	0
11	70.9348	1	1	2	0	1	2	0
12	68.9792	1	1	2	0	1	3	0
13	73.9774	1	1	2	0	2	1	0
14	74.9837	1	1	2	0	2	2	0
15	69.9957	1	1	2	0	2	3	0
16	80.9758	1	1	2	0	3	1	0
17	76.9837	1	1	2	0	3	2	0
18	67.9953	1	1	2	0	3	3	0
19	74.4145	1	2	1	0	1	1	0
20	75.4113	1	2	1	0	1	2	0
21	70.4124	1	2	1	0	1	3	0
22	76.4161	1	2	1	0	2	1	0
23	79.4019	1	2	1	0	2	2	0
24	74.4126	1	2	1	0	2	3	0
25	85.4010	1	2	1	0	3	1	0
26	83.4141	1	2	1	0	3	2	0
27	72.4239	1	2	1	0	3	3	0
28	70.8607	1	2	2	0	1	1	0
29	71.8[illegible]3	1	2	2	0	1	2	0
30	65.8821	1	2	2	0	1	3	0
31	74.3668	1	2	2	0	2	1	0
32	75.6055	1	2	2	0	2	2	0
33	70.8781	1	2	2	0	2	3	0
34	61.8774	1	2	2	0	3	1	0
35	79.8028	1	2	2	0	3	2	0
36	68.6713	1	2	2	0	3	3	0
37	75.8431	2	1	1	0	1	1	0
38	76.6264	2	1	1	0	1	2	0
39	74.6343	2	1	1	0	1	3	0
40	79.6446	2	1	1	0	2	1	0
41	80.6534	2	1	1	0	2	2	0
42	75.6348	2	1	1	0	2	3	0
43	86.6407	2	1	1	0	3	1	0
44	84.6619	2	1	1	0	3	2	0
45	73.6364	2	1	1	0	3	3	0
46	72.0950	2	1	2	0	1	1	0
47	73.1047	2	1	2	0	1	2	0

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48	71.1139	2	1	2	0	1	3	0
49	76.1216	2	1	2	0	2	1	0
50	77.1373	2	1	2	0	2	2	0
51	72.1036	2	1	2	0	2	3	0
52	83.0872	2	1	2	0	3	1	0
53	[illegible]	2	1	2	0	3	2	0
54	[illegible]	2	1	2	0	3	3	0
55	76.5181	2	2	1	0	1	1	0
56	77.5401	2	2	1	0	1	2	0
57	75.5353	2	2	1	0	1	3	0
58	80.5214	2	2	1	0	2	1	0
59	81.5365	2	2	1	0	2	2	0
60	76.5277	2	2	1	0	2	3	0
61	[illegible]	2	2	1	0	3	1	0
62	[illegible]	2	2	1	0	3	2	0
63	[illegible]	2	2	1	0	3	3	0
64	[illegible]	2	2	2	0	1	1	0
65	[illegible]	2	2	2	0	1	2	0
66	[illegible]	2	2	2	0	1	3	0
67	[illegible]	2	2	2	0	2	1	0
68	[illegible]	2	2	2	0	2	2	0
69	[illegible]	2	2	2	0	2	3	0
70	[illegible]	2	2	2	0	3	1	0
71	[illegible]	2	2	2	0	3	2	0
72	[illegible]	2	2	2	0	3	3	0

PUNCHED OUTPUT SPECIFIED

INSTRUCTOR INPUT , FACTORS INVOLVED

FACTOR	ACTIVE	TYPE	NO. LEVELS
1	YES	RANDOM	10
2	YES	RANDOM	10
3	YES	RANDOM	10
4	NO		
5	YES	FIXED	3
6	YES	FIXED	3
7	NO		

STUDENT INPUT , FACTORS USED

FACTOR	USED	TYPE	NO. LEVELS	LEVELS USED		
1	YES	RANDOM	2	1	2	
2	YES	RANDOM	2	1	2	
3	YES	RANDOM	2	1	2	
4	NO					
5	YES	FIXED	3	1	2	3
6	YES	FIXED	3	1	2	3
7	NO					

OVERALL AVERAGE

INSTRUCTOR VALUE 75.00
STUDENT VALUE 75.00

APPENDIX G

ANALYSIS OF VARIANCE RESULTS

On each printout variables are numbered sequentially from 1 by the BMDO2V program. The factors to which each correspond are written on the sheet.

The common scheme for indicating significance is adhered to. A single * denotes an effect significant at the $\alpha = 0.05$ level while a double ** indicates significance at $\alpha = 0.01$.

(1A)

PROBLEM NO. 1A

NUMBER OF VARIABLES	2
NUMBER OF REPLICATES	1

VARIABLE	NO. OF LEVELS	
1	5	Factor 1
2	4	" 2

GRAND MEAN 40.02851

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	4	132.53478	33.13370	**
2	3	1345.28619	448.42873	**
RESIDUAL	12	5.24678	.43723	
TOTAL	19	1483.06775		

(18)

PROBLEM NO. 13

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	5	Factor 1
2	4	" 2

GRAND MEAN 39.93045

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	4	67.05719	16.76430	
2	3	1026.77737	342.25912	*
12	12	3.57382	.29782	
WITHIN REPLICATES	20	1944.18158	97.20908	
TOTAL	39	3041.58995		

PROBLEM NO. 1C

(1C)

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 3

VARIABLE	NO. OF LEVELS	
1	5	FACTOR 1
2	4	" 2

GRAND MEAN 39.95636

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	4	42.61717	10.65429
2	3	445.53910	148.51303
12	12	6.15092	.51258
WITHIN REPLICATES	40	4167.74712	104.19368
TOTAL	59	4662.05430	

PROBLEM NO. 10

10

NUMBER OF VARIABLES	2
NUMBER OF REPLICATES	1

VARIABLE	NO. OF LEVELS	
1	5	FACTOR 1
2	4	" 3

GRAND MEAN 40.78142

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	4	297.58678	74.39670
2	3	114.26408	38.08803
RESIDUAL	12	1320.63578	110.05298
TOTAL	19	1732.48664	

PROBLEM NO. 12

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	3	FACTOR 1
2	3	" 2
3	3	" 3

GRAND MEAN 36.68437

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	2	321.60311	160.80155	**
2	2	1349.95365	674.97682	**
3	2	2.06449	1.03224	
12	4	1.62283	.40571	
13	4	2.04345	.51086	
23	4	7.55935	1.88984	**
RESIDUAL	8	2.75555	.34444	
TOTAL	26	1587.60244		

1E

PROBLEM NO. 1F

(1F)

NUMBER OF VARIABLES	2
NUMBER OF REPLICATES	1

VARIABLE	NO. OF LEVELS	
1	4	FACTOR 5
2	4	" 6

GRAND MEAN 42.22176

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	3	258.30012	86.10004
2	3	314.01795	104.67265
RESIDUAL	9	501.21699	55.69078
TOTAL	15	1073.53506	

(2A)

PROBLEM NO. 2A

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	6	FACTOR 5
2	4	" 6

GRAND MEAN 55.16887

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	5	1186.16950	237.23390	**
2	3	127.06963	42.35321	**
RESIDUAL	15	101.16105	6.74407	
TOTAL	23	1414.42017		

PROBLEM NO. 23

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	6	FACTOR 5
2	4	" 6

GRAND MEAN 54.52935

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	5	287.15144	57.43029
2	3	131.18062	43.72687
12	15	22.18920	1.47928
WITHIN REPLICATES	24	1990.99251	82.95802
TOTAL	47	2431.51376	

PROBLEM NO. 20

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 3

VARIABLE	NO. OF LEVELS	
1	6	FACTOR 5
2	4	" 6

GRAND MEAN 54.77520

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	5	501.17905	100.23581
2	3	66.05557	22.01852
12	15	90.31594	6.02106
WITHIN REPLICATES	48	3004.54813	62.59475
TOTAL	71	3[illegible].09863	

2C

PROBLEM NO. 2D

(2D)

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 4

VARIABLE	NO. OF LEVELS	
1	6	FACTOR 5
2	4	" 6

GRAND MEAN 54.83917

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	5	340.23555	68.04711
2	3	7.50390	2.50130
12	15	25.04970	1.66998
WITHIN REPLICATES	72	4721.45112	65.57571
TOTAL	95	5094.24029	

2E

PROBLEM NO. 2E

NUMBER OF VARIABLES 1
NUMBER OF REPLICATES 5

VARIABLE	NO. OF LEVELS	
1	4	FACTOR 5

GRAND MEAN 51.67253

MEANS	3	8.86322	2.95441
WITHIN	16	630.87217	39.42951
TOTAL	19	639.73540	

PROBLEM NO. 3A

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	6	FACTOR 5
2	4	" 6

GRAND MEAN 55.11413

(3A)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	5	221.10572	44.22114
2	3	86.81753	28.93923
12	15	34.77357	2.31824
WITHIN REPLICATES	24	2051.76810	85.49034
TOTAL	47	2394.46493	

PROBLEM NO. 38

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	2	FACTOR 1
2	6	" 5
3	4	" 6

(38)

GRAND MEAN 54.62938

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	1	29.28344	29.28344	**
2	5	2143.51467	428.70293	**
3	3	215.97501	71.99167	**
12	5	.00008	.00002	
13	3	.00024	.00008	
23	15	132.02669	8.80178	**
RESIDUAL	15	.00032	.00002	
TOTAL	47	2523.80040		

BMD02V - ANALYSIS OF VARIANCE FOR FACTORIAL DESIGN - VERSION OF DEC. 13, 1963
HEALTH SCIENCES COMPUTING FACILITY, UCLA

PROBLEM NO. 4A

(4A)

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	3	FACTOR 5
2	3	" 6
3	3	" 7

GRAND MEAN 125.04625

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	2	157.02020	78.51010	**
2	2	3155.76384	1577.88192	**
3	2	119.27843	59.63922	*
12	4	65.59894	16.39974	
13	4	60.58757	15.14689	
23	4	62.35904	15.58976	
RESIDUAL	8	67.97073	8.49634	
TOTAL	26	3688.57875		

PROBLEM NO. 43

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	3	Factor 5
2	3	" 6
3	3	" 7

GRAND MEAN 124.95348

(48)

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	2	355.39004	177.69502
2	2	2163.34677	1081.67438 *
3	2	66.09223	33.04612
12	4	38.30890	9.57722
13	4	43.82289	10.95572
23	4	20.83757	5.20939
123	8	26.79327	3.34916
WITHIN REPLICATES	27	4730.45608	175.20215
TOTAL	53	7445.05174	

PROBLEM NO. 4C

4C

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS		
1	2	FACTOR	1
2	3	"	5
3	3		6

GRAND MEAN 126.12372

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	1	2841.69665	2841.69666	**
2	2	1530.25918	765.12959	**
3	2	253.97997	126.98999	**
12	2	624.67409	312.33705	**
13	2	11.56301	5.78150	
23	4	121.15663	30.28916	*
123	4	143.60618	35.90154	*
WITHIN REPLICATES	18	156.29928	8.68329	
TOTAL	35	5683.23500		

PROBLEM NO. 4D

4D

NUMBER OF VARIABLES	3
NUMBER OF REPLICATES	3

VARIABLE	NO. OF LEVELS	
1	2	Factor 5
2	2	" 6
3	2	" 7

GRAND MEAN 129.13052

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	1	19.44684	19.44684
2	1	525.02680	525.02680
3	1	52.54119	52.54119
12	1	.22905	.22905
13	1	.02684	.02684
23	1	.07089	.07089
123	1	25.17852	25.17852
WITHIN REPLICATES	16	5052.69671	315.79354
TOTAL	23	5675.21884	

4E

PROBLEM NO. 4E

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS		
1	3	FACTOR	5
2	3	"	6
3	3		7

GRAND MEAN 124.98394

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	2	362.26164	181.13082
2	2	2143.83106	1071.91553
3	2	63.82737	31.91369
12	4	41.34976	10.33744
13	4	43.90129	10.97532
23	4	23.37025	5.84256
123	8	22.73601	2.84200
WITHIN REPLICATES	27	4695.95606	173.92430
TOTAL	53	7397.23345	

PROBLEM NO. 4F

4F

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	3	Factor 5
2	3	" 6
3	3	" 7

GRAND MEAN 124.97613

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	2	156.14469	78.07235	**
2	2	3119.51353	1559.75676	**
3	2	139.49180	69.74590	**
12	4	65.75207	16.43802	
13	4	70.05379	17.51345	
23	4	66.83544	16.70886	
RESIDUAL	8	69.24467	8.65558	
TOTAL	26	3687.03599		

PROBLEM NO. 5A

5A

NUMBER OF VARIABLES	2
NUMBER OF REPLICATES	1

VARIABLE	NO. OF LEVELS	
1	5	FACTOR 5
2	4	7

GRAND MEAN 21.53415

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	4	126.34008	31.58502	**
2	3	6.74700	2.24900	
RESIDUAL	12	34.39043	2.86587	
TOTAL	19	167.47752		

PROBLEM NO. 53

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 2

(5B)

VARIABLE	NO. OF LEVELS	
1	5	FACTOR 5
2	4	" 7

GRAND MEAN 20.53334

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	4	23.39803	5.84951
2	3	.95993	.31998
12	12	32.76861	2.73072
WITHIN REPLICATES	20	118.68043	5.93402
TOTAL	39	175.80699	

PROBLEM NO. 5C

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	5	FACTOR 1
2	4	" 3

GRAND MEAN 23.55552

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	4	17.82252	4.45563
2	3	15.34449	5.11483
RESIDUAL	12	69.72433	5.81036
TOTAL	19	102.89132	

5C

PROBLEM NO. 50

50

NUMBER OF VARIABLES	2
NUMBER OF REPLICATES	2

VARIABLE	NO. OF LEVELS	
1	3	FACTOR 5
2	3	" 7

GRAND MEAN 20.50006

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	2	5.71955	2.85977
2	2	1.02843	.51421
12	4	9.25665	2.31416
WITHIN REPLICATES	9	61.59677	6.84409
TOTAL	17	77.60140	

PROBLEM NO. 5E

NUMBER OF VARIABLES 1
NUMBER OF REPLICATES 4

VARIABLE NO. OF LEVELS
1 4 FACTOR 5

5E

GRAND MEAN 28.90821

MEANS	3	4.66563	1.55521
WITHIN	12	31.76379	2.64698
TOTAL	15	36.42942	

PROBLEM NO. 6A

6A

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	3	FACTOR 5
2	3	" 6
3	3	" 7

GRAND MEAN 101.38891

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	2	82.26594	41.13297	
2	2	5.35874	2.67937	
3	2	9.01071	4.50535	
12	4	107.63906	26.90976	**
13	4	17.00797	4.25199	
23	4	.00000	.00000	
123	8	21.98444	2.74805	
WITHIN REPLICATES	27	398.13749	14.74583	
TOTAL	53	641.40435		

PROBLEM NO. 6B

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	3	FACTOR 5
2	3	" 6
3	3	7

GRAND MEAN 103.18072

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	2	78.16135	39.08068
2	2	1.54940	.77470
3	2	8.99230	4.49615
12	4	90.03255	22.50814
13	4	17.00194	4.25049
23	4	.00001	.00000
123	8	21.99827	2.74978
WITHIN REPLICATES	27	354.68595	13.[illegible]
TOTAL	53	582.42175	

(6B)

PROBLEM NO. 7A

7A

NUMBER OF VARIABLES 2
NUMBER OF REPLICATES 8

VARIABLE	NO. OF LEVELS	
1	3	FACTOR 5
2	3	" 6

GRAND MEAN 75.63333

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	2	2.15156	1.07578
2	2	18.74346	9.37173
12	4	22.74763	5.68691
WITHIN REPLICATES	63	1632.63044	26.70642
TOTAL	71	1726.27308	

PROBLEM NO. 73

NUMBER OF VARIABLES 3
NUMBER OF REPLICATES 4

VARIABLE	NO. OF LEVELS	
1	2	FACTOR 1 (BLOCK)
2	3	" 5
3	3	" 6

(78)

GRAND MEAN 72.89318

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES
1	1	1.[illegible]72	1.80972
2	2	22.4[illegible]2	11.20591
3	2	39.7[illegible]22	19.89361
12	2	380.[illegible]25	190.04213
13	2	4.29332	2.14666
23	4	22.71558	5.67664
123	4	63.89332	15.97458
WITHIN REPLICATES	54	1349.4[illegible]7	24.99371
TOTAL	71	1884.4[illegible]	

← indicate only factors of interest

PROBLEM NO. 7C

7C

NUMBER OF VARIABLES 4
NUMBER OF REPLICATES 2

VARIABLE	NO. OF LEVELS	
1	2	Factor 1 (Block)
2	2	" 2 (Block)
3	3	" 5
4	3	" 6

GRAND MEAN 71.73397

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	1	75.22492	75.22492	
2	1	121.20726	121.20726	
3	2	354.49846	177.24923	**
4	2	118.52149	59.26074	**
12	1	.37790	.37790	
13	2	.89526	.44763	
14	2	2.43122	1.21561	
23	2	574.49463	287.24732	
24	2	121.66657	60.83329	
34	4	13.75354	3.43839	
123	2	1.45490	.72745	
124	2	.37257	[illegible]	
134	4	6.74998	[illegible]	
234	4	53.90353	[illegible]	
1234	4	1.59728	[illegible]	
WITHIN REPLICATES	36	88.44642	[illegible]	only factors of interest
TOTAL	71	1535.28593		

NUMBER OF VARIABLES 5
NUMBER OF REPLICATES 1

VARIABLE	NO. OF LEVELS	
1	2	FACTOR 1 (BLOCK)
2	2	" 2 (BLOCK)
3	2	" 3 (BLOCK)
4	3	" 4
5	3	" 5

GRAND MEAN 76.25878

7D

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUMS OF SQUARES	MEAN SQUARES	
1	1	81.00757	81.00757	
2	1	14.40351	14.40351	
3	1	224.59281	224.59281	
4	2	432.35827	216.02914	← **
5	2	576.43808	288.21904	← **
12	1	.00009	.00009	
13	1	.00015	.00015	
14	2	.00013	.00006	
15	2	.00011	.00005	
23	1	.00008	.00008	
24	2	.00007	.00003	
25	2	.00001	.00000	
34	2	.00036	.00019	
35	2	.00008	.00004	
45	4	336.38541	84.09635	← **
123	1	.00010	.00010	
124	2	.00020	.00010	
125	2	.00026	.00013	
134	2	.00015	.00008	
135	2	.00011	.00006	
145	4	.00033	.00008	
234	2	.00002	.00001	
235	2	.00065	.00032	
245	4	.00012	.00003	
345	4	.00022	.00005	
1234	2	.00020	.00010	← only factor of interest
1235	2	.00003	.00001	
1245	4	.00071	.00018	
1345	4	.00009	.00002	
2345	4	.00039	.00010	
RESIDUAL	4	.00075	.00019	
TOTAL	71	1665.19110		